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The Household Physician

A Family Guide to the Preservation of Health
and to the Domestic Treatment of Ailments
and Disease, with Chapters on Food and
Drugs and First Aid in Accidents and Injuries

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Illustrated by about 400 Figures in the Text and a Series of Engraved Plates

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PART II.

HYGIENE, OR A CONSIDERATION OF THE EXTERNAL CIRCUMSTANCES WHICH AFFECT THE HEALTH OF INDIVIDUALS AND COMMUNITIES.

INTRODUCTION.

The word *hygiene* is originally French, and means the science of health. It is derived from the Greek *hugieinos*, meaning "good for the health." It implies the study of everything outside of a person's own body which has an influence on his health. In the introduction to Part I., health has been viewed as the result of the harmonious co-operation of all the organs of the body in a sound condition. These we might call the internal conditions of health. It is clear, however, that if we limit our view to these internal conditions, we overlook a large number of circumstances which have an immediate and constant influence on the state of the body. Disease is more frequently due to a cause acting from without than to some condition originating from within. If, therefore, we are to have a fair all-round view of the conditions of health, we must give a careful study to the surroundings of a person, and observe how he is affected by them, we must study the conditions external to him, which directly and more or less constantly have a relation to his life. It is with these surroundings that the science of hygiene has to deal.

Now, the most striking of the outside agencies which constantly influence the bodily condition are the food a person eats, the liquids he drinks, and the air he breathes. These have already been considered (in Part I.), so far as was needful for our understanding of their general use within the body. But all details regarding, for example, the nature and composition of foods, the sources of foods, and the relation between their composition and their value to the human body, the varieties of liquids in common use, their varying properties and consequent effects upon the body, the various atmospheric conditions included under the term climate, and the influence they have upon human life, have been omitted in Part I. as foreign to the immediate purpose in hand. Yet they are all of the utmost importance. Again, the activity of the skin depends largely on the degree of heat and moisture of the external atmosphere, and the activity of the skin is remarkably related to the action of the kidneys, so that a change in the external atmosphere will profoundly affect the whole body. We can modify or alter the influence exerted by the atmosphere by the nature and amount of clothing worn. So it becomes of extreme interest to ask how and why clothing influences health. Further, while a person cannot voluntarily or directly affect the action of his heart, the activity of his circulation, or the rate at which his liver and kidneys remove waste from the body, he may indirectly but powerfully influence all these by the kind of work or exercise he engages in. Therefore the effects of exercise on health, whether in the form of work or play, become an important part of the study of hygiene.

In the next place we must remember how materially man alters the natural conditions of life, how very different, for example, may be the atmosphere he breathes from that he was, so to speak, designed to breathe, because of the nature of the dwelling in which he lives, because of the alteration of the composition of the air from the addition to it of foreign particles, produced by various kinds of industry, such as chemical works, or by metal grinding, such as brass grinding, &c., or because of additions to the air of organic impurities, such as are cast off from his own body in the course of its natural activity. So that in face of the ever-increasing developments of modern industry, the continual new departures which modern industrial progress renders necessary, and the new and unusual conditions of life they create, it becomes more and more a daily and urgent necessity that the principles of health should be studied, and their bearings on new conditions realized.

Every one who endeavours to arouse the public interest in such questions, and to direct the public attention to them, is met by the question, "How comes it that our forefathers lived healthy and useful lives in spite of their ignorance of such principles, and how should we not be as healthy as they without such knowledge?" The answer is, that the tendency for men to mass themselves together in large communities has never been so marked as in quite recent times; and it is the formation of large communities and the growth of crowded cities that create conditions hostile to health, and render necessary the deliberate facing of the question how, in spite of such hostile conditions, health may yet be preserved. Men must be considered in the relationship they bear to one another, simply in virtue of their proximity to one another, and in view of the influence they exert on one another because of that proximity.

Each individual gives off organic material from his lungs, from his skin, from his kidneys, and from his bowels, which it is highly undesirable that his neighbour should get the benefit of, and exceedingly undesirable if he happens to be suffering from a disease, which may be communicated by such means, as many diseases may be (see Part I., section XIII.). In the ordinary course such organic materials would undergo destruction by natural agencies. In contact with the air they suffer oxidation or combustion, by which they are reduced to simple and harmless substances. Material cast off from the body and thrown upon the surface of the earth rapidly undergoes such combustion; discharged into the running stream, it is equally destroyed by the agency of the oxygen contained in the air dissolved by the water. Now, while "the self-cleansing properties of nature" are sufficient to effect their purpose speedily, where men live in scattered groups over a country, it is very different when men are so crowded together that the amount of air-space and earth-space for each becomes reduced to a minimum. To take an actual illustration, "there are ten rural counties in Scotland inhabited at the rate of only 41 persons per square mile, on the average of the ten years 1866–1875, while in Glasgow we endeavour to live in the proportion of 53,224 persons per square mile." Supposing the persons to be equally distributed over the square mile, then "in the ten rural counties each man, woman, and child enjoys an ample area of 16 acres, and is 296 yards from each of his or her neighbours; while in Glasgow each citizen is 'cribbed, cabined, and confined' within less than $\frac{1}{80}$th of an acre, and is only 8 yards from his nearest neighbours." In the former condition of affairs the amount of air-space and earth-space is sufficient to ensure the constant maintenance of healthy surroundings and the speedy destruction, by natural means, of waste organic products. In the latter case the amount of waste is so enormous that nature has no room to deal with it, and special means need to be devised for the removal from the community of the waste, whose accumulation means serious injury to health. One is, therefore, not surprised to learn that "in the rural counties only 17 per 1000 of these happy people die annually, while in Glasgow fully 30 perished in each of the years from 1866 to 1875. Shall we say that in Glasgow we choke and hustle each other out of existence?" (Dr. Russell). In proportion as men crowd together, in a similar proportion does disease multiply and the death-rate increase. So we get hold of "the idea, that vast as are the resources of nature, they are not without limits; and that as we add house to house, and man to man, in our cities, we had better have a care how we do it." Thus hygiene does not only study health in relation to the individual but in its bearings on communities, and we have the departments of private and public health established. Inasmuch, then, as each individual in a community may, by his mode of life, by its effects on his surroundings, seriously affect the welfare of his neighbours, and inasmuch as his neighbours may have no power themselves to put an end to his injurious influence, it becomes necessary to have some state regulation of the conduct of individuals in relation to a community, and there thus arises what is termed "State Medicine."

Hygiene, then, embraces within its scope not only the study of the principles of health in regard to the individual, the food he eats, the water he drinks, the air he breathes, the clothing he wears, the exercise he engages in, the dwelling in which he lives, the occupation at which he is employed, and the means by which the cast-off waste products of his body are removed from his immediate surrounding, but also, in regard to communities, the steps which are to be taken to prevent the accumulation of such waste products and the consequent spread of disease among the community, and such like questions.

In this portion of the book it will be our business to study food, drink, air, exercise, clothing, removal of waste, ventilation, drainage, &c., in their bearings on health, in an order such as has been indicated.

SECTION I.—FOODS.

Food and Energy:
- *The Meaning of Energy*—Potential and Actual Energy;
- *The Sources of Energy; The Conservation and Transformation of Energy;*
- *The Energy of Heat and of Mechanical Work*—The Mechanical Equivalent of Heat
- *Food as a Store of Energy*—The Energy obtained from various Foods by Burning.

The Chemical Composition of the Human Body:
- *Chemical Elements found in the Body;*
- *Chemical Compounds found in the Body*—Water, Inorganic Salts, Proteids, Starches and Sugars, Fats—Percentages of Proximate Principles of the Body.

The Nature and Chemical Composition of Food-stuffs:
- *The Classification of Foods*—Proximate Principles of Food (Water, Salts, Proteids, Starches, Sugars, Fats);
- *The Fate of various Food-stuffs and their Uses in the Body.*

The Composition of Animal Foods:
- I. *Nitrogenous Animal Foods*—
    - *Butchers' Meat*—Beef, Mutton, Pork, Veal;
    - *Various Parts of Animals*—Liver, Kidney, Tripe, Bacon, Foie Gras;
    - *Poultry and Game; Eggs;*
    - *Fish*—Whiting, Haddock, Cod, Sole, Salmon, Herring, Mackerel, Eel, &c., Caviare, Poisonous Fish;
    - *Shell-fish*—Lobsters, Crabs, Oysters, Mussels, &c.;
    - *Milk*—Average Composition of Different Animals' (Cow, Ass, Goat, Mare, Sheep), compared with Human Milk—Characters of Milk and Variations due to Feeding, &c.; Cream, Buttermilk, &c.; Koumiss;
    - *Cheese*—Composition and Qualities of various kinds (Stilton, Cheddar, Gorgonzola, &c.);
- *Various Animal Foods Compared.*
- II. *Non-Nitrogenous Animal Foods*—
    - *Butter, Lard, Dripping, Oleo-margarine or Butterine,* &c.

The Composition of Vegetable Foods:
- I. *Nitrogenous Vegetable Foods*—
    - *Cereals or Grains*—Wheat Flour and Bread, Food-stuffs made from Wheat (Semolina, Macaroni, Vermicelli), Oats and Oatmeal, Barley, Rye, Maize or Indian Corn, Rice, Millet, Buckwheat, Dari or Durra;
    - *Leguminous Plants or Pulses*—Peas, Beans and Lentils;
    - *Tubers and Roots*—Potatoes, Sweet-potato, Yam, Carrots, Turnips, Beet-root, Parsnip, Jerusalem Artichoke, Radishes, Salsify;
    - *Herbaceous Articles*—Cabbage, Cauliflower, Savoy, &c., Spinach, Celery, Rhubarb, Sea-kale, Onion, Asparagus, Lettuce, Endive;
    - *Fruits*—Cucumber, Vegetable Marrow, Tomato, Apples, Pears, Plums, Grapes, Figs, Dates, Bananas, Bread-fruit, Nuts and other Fruits;
    - *Fungi*—Mushroom, Morel, Truffles;
    - *Sea-weed*—Moss, &c.
- II. *Non-Nitrogenous Vegetable Foods*—
    - *Starchy Foods*—Sago, Corn-flour, Arrow-root, Tapioca and Cassava, Tous-le-mois;
    - *Sugary Foods*—Sugar, Treacle and Syrup, Honey, Manna;
    - *Vegetable Oils.*
- III. *Condiments.*
- *Comparison between Animal and Vegetable Foods.*

The Adulterations of Food-stuffs, and Unwholesome Food.

The Digestibility of Food:
- *Time occupied in Digestion of Different Foods;*
- *The Quantity of Different Foods that is Digested.*

The Principles of Cooking.

The Construction of Dietaries:
- *Quantity of Food required per Day*—Standard Diet, Starvation Diet.
- *Variations in Quantity caused by Age, Sex, Work, or Exercise;*
- *The Regulation of Diet according to Season or Climate;*
- *Diet for Training;*
- *Economy in Diet*—What Kind of Diet yields Everything required for Health and Work, at least cost?
- *Effects of Excessive or Deficient Diet;*
- *Diet suitable for Special Bodily Conditions*—Corpulence (Banting's System), Diabetes, Gout, &c.
- *Diets for Invalids and Infants*—Beef-tea, Artificially Digested Foods, Analyses of Various Infants' and other Prepared Foods.

The Preservation of Food.

FOOD AND ENERGY.

The Meaning of "Energy."—The human body has already been compared to a steam-engine in working order. If the engine is to be kept working and in good condition two things are needful—(1), the engineer must repair regularly any tear and wear, the result of the working of the machine, and (2), a regular supply of fuel must be kept up to maintain the steam. The full meaning of the first of these conditions is plain enough; it will help us materially in arriving at a proper understanding of the nature and purpose of food if we consider more fully what the second implies.

The steam-engine, as it stands completed in the engineer's shop, may be a perfect instrument, and yet it will stand motionless and idle, till "the crack o' doom," unless something more be supplied to it. It possesses all the working parts, properly connected together, but it has no motive power. It lacks *the power of doing work*, that is it possesses no energy, for "energy" is defined as the power of doing work. How does the steam-engine obtain this power? It obtains it from steam at high pressure. Steam at high pressure possesses energy, energy stored up, so long as the steam is imprisoned in the boiler; but as soon as the steam is allowed to expand into the cylinder against the piston-rod, its energy is liberated, and appears in the form of mechanical movement, in the motion of the piston and the wheels to which it is connected. The energy, or power of doing work, stored up in steam at high pressure becomes transformed into energy liberated, work actually done, in the moving steam-engine as it lifts or transports the load attached to it. Thus we may have energy stored up, or as it is called **potential energy**, the power of doing work not in operation, and we may have energy liberated, **actual energy**, the power of doing work in actual operation. There are many illustrations of this difference between potential or stored energy and actual energy. A water-dam is a store of energy. The dammed-up water has the power of doing work, but so long as it is confined behind its barriers it remains only potential energy. If the gates are raised and the water allowed to flow away, its energy is liberated, and in its course to the sea may turn many mill-wheels, so that the potential energy of the dammed-up water becomes transformed into the actual energy of the mill-stones as they grind the flour. A wound-up clock-spring is another illustration of potential energy. While the spring is held by its catch the energy is stored, but as soon as the spring is permitted slowly to uncoil, its energy is liberated, becomes actual, and appears in the movement of the clock-work. Thus steam at high pressure, a head of water, a coiled spring are all illustrations of energy in the potential condition, capable of becoming changed into actual energy, as soon as the steam is permitted to expand, the water to seek the low level, and the spring to uncoil. The winds are illustrations of actual energy, energy being liberated, actual energy which is utilized by the sails of a ship or the arms of a windmill.

The Sources of Energy.—Now the question arises, where did the energy in each case come from? how does steam or a head of water or a coiled spring come to possess the power of doing work? Take the head of water to begin with. It is plain that its power of doing work is due to its position above the sea-level. As soon as it reaches the sea-level its power of doing work is gone. It is the mass of water in its course downwards to the sea that can do work. It is also plain that the higher the dam is above the sea-level, and the larger the quantity of water collected in it, the more work will be got out of it, the larger and the more numerous may be the mill-wheels which it will turn in its downward course. In short, if the height of the water above the sea-level be known, and the quantity of water in the dam, one could obtain an exact idea of the stored-up energy it represented, and of the amount of work that could be got out of the water in its descent. Suppose two dams, containing each the same quantity of water, but one only half the height above sea-level of the other, the water flowing from the high one would be able to do twice the amount of work done by the water from the low one. In short, the energy of falling water is the same as that of a falling weight, which depends on the amount of the weight and the distance through which it has to fall. The stored-up energy of a head of water may, then, be called potential energy *of position*, and the question, how did the water come to possess energy? will be answered if we can tell how the water came to be so high above the sea-level. The answer is easy. The water is the collected rain which has fallen. And what is the rain? Rain is originally vapour raised from the sea, &c., by the heat of the sun. The warm vapour passing through the atmosphere comes into contact with colder portions, clouds are formed, and finally the vapour is condensed by the cold and falls as rain. Collected in the uplands it forms a head of water. It is the heat of the sun, then, that raised the water from the sea-level to the height, just as truly as a man may raise a weight from the ground and place it in a high position; and the energy of the head of water is really stored-up energy, which at a previous time had been liberated from the sun. The actual energy of the sun, as it does work in raising water from the ocean as vapour, becomes transformed into the potential energy of the mill-dam, and the potential energy of the mill-dam becomes re-transformed into the actual energy of the falling water as it turns the mill-wheel. When the water reaches the sea—and part of it before that—it may become again raised by the sun's heat in the form of vapour to fall as rain among the hills, and the circle of transformation may go on again. The power of doing work possessed by a head of water is thus derived from the sun. What of the energy of winds? Winds are due to differences of temperature in the air, the differences producing currents in the atmosphere. Take the case of the trade-winds. The sun's rays, beating directly upon the equator, heat enormous masses of air, which rise and flow north and south towards the colder regions of the poles, while colder currents flow in from both sides to the equator, become heated, and in their turn rise and spread outwards above. The energy of wind currents is thus also derived from the sun.

Let us think of the coiled spring, whence is its energy obtained? The spring was coiled by the strength of someone's hand. The person who turned the key expended energy, did work, in the act. But the energy liberated from the muscles of his hand and arm as he turned the key was not lost; it was being stored in the coiling spring, and would again be liberated in keeping the clock-work going. The energy of the person's muscle was derived from food consumed, and we shall see by and by (p. 528) that this energy too is in its origin traceable back to the sun.

Now let us return to the steam-engine; its energy is derived from pressure of steam, but how is the potential energy of steam at high pressure obtained? The steam is raised from water, placed in a boiler over a furnace in which fuel, let us say coal, is burned. It is the heat derived from burning coal that raised the steam so abundantly. So that the mechanical work done by the engine is derived, through pressure of steam, from the energy of heat. It appears, then, so far as the steam-engine is concerned, that the energy it liberates in doing work is derived from coal. The coal is the store of energy, a mass of potential energy, and, in the act of burning, its stored-up energy is liberated and appears, through the medium of the mechanical parts of the engine, as mechanical work. But how does the coal come to be a store of energy—what is coal? Of every pound of coal rather more than $\frac{3}{4}$ths consist of the chemical element called carbon. Now carbon has a strong attraction for oxygen gas, the chief gas in ordinary atmospheric air. When carbon and oxygen unite, there is formed a third substance, which, in ordinary circumstances, is a colourless gas. This union takes place with such force that an enormous quantity of heat is produced. If any two bodies are caused violently to clash together heat is produced by the force of collision. If cold iron be rapidly hammered on an anvil, in a short time it will be perceptibly warm. The particles of carbon having a strong chemical attraction for the particles of oxygen gas, as soon as they get the opportunity they rush together, and the collision of the uniting particles liberates heat. So, at least, we may explain it to our minds. To this process of uniting with oxygen the terms **burning**, **combustion**, or **oxidation** are applied. If we were to express in scientific terms such an ordinary everyday fact as that "the fire burns," we might say "the coal is undergoing oxidation in the grate." It is not necessary to speak by the card in this way, but it is very necessary to remember that, when the fire burns, what is really happening is that the carbon, of which the coal mainly consists, is uniting with the oxygen contained in the air, with the result that carbonic acid gas, among other products, is formed and escapes up the chimney, and a great amount of heat is given off by the force of the chemical combination. In the case of coal the union with oxygen needs encouragement to begin with, and the needed encouragement is afforded by applying a light to the coal. Once it has made a start it goes on, however, vigorously, provided the supply of oxygen is plentiful, provided, that is, there is plenty of air, and a draft of air to bring fresh supplies to the fire. Everybody knows that, if the chimney "will not draw," the fire goes out, that is, there is not sufficient draft to bring fresh supplies of air (which contains the oxygen) quickly enough to permit the union to go on. If the fire is languishing, someone goes for the bellows and speedily blows the fire into a blaze; that is, by means of the bellows large quantities of oxygen are quickly driven into the fire, and the rate of chemical combustion is so much increased that the heat becomes very great. It is in this process of union with oxygen, then, or oxidation process, that heat is liberated; and heat is liberated wherever that process occurs. The heat may not be perceptible if the process is slow, but wherever the process is very rapid the heat is great. We are thus enabled to understand that the energy of heat as thus derived is the result of the energy of chemical attraction.

But we have not yet answered fully the question of the source of the energy of coal. How did carbon come to be in the form of coal? Coal is derived from vegetable matter. Beds of coal were originally masses of vegetation, perhaps in some primeval forest. The vegetable matter has become covered over, and, under the influences of temperature, moisture, and pressure, chemical changes have gone on in the slow course of ages, which have resulted in converting the original plants, shrubs, and trees also, it may be, into masses of coal. The carbon, then, of the coal has originally formed part of the structure of a living plant. Now the carbon does not exist in the living plant in the simple form of the chemical element, but built up into highly complex compounds in the form of fats, oils, starches, and sugars. All these are compounds of carbon manufactured or built up by the plant in the course of its life. The plant obtains the carbon, which it thus builds up, from the atmospheric air, in which it exists in the form of the gas we have already mentioned, carbonic acid gas. That gas, we have seen, is a chemical compound of carbon and oxygen, and the plant seizes upon this compound in the air, splits it up, liberates the oxygen, retains the carbon and builds it up in its body into the complex fats, starches, &c. In this building-up process the plant does work, just as a man does work in lifting a weight or coiling a spring, and the energy it thus expends is stored up in its body in the starch or fat it has manufactured, just as a man stores up the energy, expended in lifting the weight or coiling the spring, in the weight he has lifted or the spring he has coiled. The plant, therefore, stores energy in the complex carbon compounds it produces. Where did the plant get the energy to do this? It has been shown that the plant can only separate carbon from the atmosphere and build it up in its own body *under the influence of the sun's rays.* Unless the sun's rays were poured upon it it would cease to do this and die. In the end it comes to this, then, and this is the important point, that the energy of the plant is derived from the sun, and that the energy of the sun's rays is stored up in the plant in the form of fats, oils, sugars, and starches, and such carbon compounds. This stored-up energy becomes, under the influence of temperature, pressure, &c., already referred to, the stored-up energy of coal. When we burn coal we liberate, by the agency of chemical combination, the energy which, countless years before, the plant had stored up from the sun's rays, and, by appropriate means, convert it into the energy of steam at high pressure, and then obtain it as work done in the form of mechanical motion.

Thus we find the energy of a head of water, of currents of air, and of coal, are ultimately derived from the sun, from which source there thus really proceeds practically all the power of doing terrestrial work.

In the case of coal we see a remarkable circle of changes similar to that observed in the case of a head of water. The plant stores the energy of the sun; in time the stored energy reaches us as coal. We burn the coal and liberate the energy. In this act carbonic acid gas is formed and passed into the atmosphere. The plant seizes upon the gas and under the influence of the sun again converts the carbon into a store of energy, to be again liberated, and so on.

Further, we have traced the building up of fats, oils, starches, and sugars in the plant to the energy of the sun. But these form a large portion of man's food, and the exclusive food of animals used by man for food—the ox, sheep, &c. The food of man is then the stored-up energy of the sun, which man takes into his body. In his body he liberates that energy in the form of heat and mechanical work, so that the energy he expends in lifting a weight, coiling a spring, &c., is energy derived originally from the sun.

The Conservation and Transformation of Energy.—In the preceding paragraphs we have had illustrations of the fact, the discovery and proof of which form one of the chief triumphs of modern science, that energy is never lost. When energy seems to disappear, in reality it does not do so; it simply assumes another form. The energy of chemical action may become transformed into the energy of heat, that of heat may assume the form of mechanical work. The energy expended in the form of mechanical work, as in lifting a weight, is not lost, but becomes potential energy of position, for the weight as it descends may do work or liberate heat and so on. Thus we have an idea of what is meant by the modern law of the conservation of energy, the law which states that energy is never lost, and also of what is meant by the transformation of energy, which explains what takes place when energy seems to disappear. The right understanding of this is of the utmost importance in our study of foods.

The Energy of Heat and of Mechanical Work.—Let us return again to our illustration of the steam-engine. We have seen that the power of doing work possessed by the steam-engine is obtained from the coal in the form of heat. If it is true that energy is never lost, and if we suppose our engine to be a perfect one, so that all the heat given off from the coal is converted into work done by the engine, then the amount of work which the engine can do ought to be exactly measured by the amount of heat given off from the coal. Is this true? Does a certain amount of heat always represent a certain amount of mechanical work, so that given a certain amount of heat, one can calculate from it the amount of mechanical work, assuming that all the energy of heat is converted into work done? There is such a definite relation, and it was proved by two men, working independently of one another, Julius Robert Mayer (1842), a Schwabian physician, and James Prescott Joule (1845–1847), a manufacturer of Manchester. To determine the relationship, it is plain one must have to begin with standards of measurement for heat and work done, just as to determine the weight of any body one must have a standard of weight, namely, the pound weight. The standard measure of heat is the amount of heat necessary to raise the temperature of one pound weight of water at the freezing-point one degree on the Fahrenheit scale. This amount of heat is called the unit of heat, and is called the **calorie**, as the standard of weight is called the pound, or the standard of length the yard. Ten pounds weight of water heated by 1 degree Fahrenheit represent 10 heat units, or 10 calories. The standard of work is the amount of work done in raising a weight of 1 pound 1 foot high. This is the unit of work or the **foot-pound**. When a man raises a weight of 1 stone 1 foot high, he is said to do 14 foot-pounds of work, and if he raises 2 stones (28 pounds) 10 feet high, he does 280 (28 multiplied by 10) foot-pounds of work. Now, the question is, is there any exact relation between the calorie, or unit of heat, and the foot-pound, or unit of work? for if there is, it will be necessary only to measure how many units of heat are given off from the burning of 1 pound of coal to determine how much mechanical work can be got out of the energy thus liberated from the coal. Now, we have said that a man expends energy in raising a weight to a certain height, and the quantity of energy depends on the weight and the height to which he has lifted it; and further, that the energy thus expended is stored up in the weight; when the weight is allowed to fall the energy is liberated. If the weight have a cord attached to it and the cord be wound round some piece of clock-work, the liberated energy will be employed in doing work. If a weight of 10 lbs. be raised 50 feet, then it has stored up in it 500 foot-pounds of energy. Well then, to determine the relation between heat and mechanical work, Joule used an apparatus represented in Fig. 190.

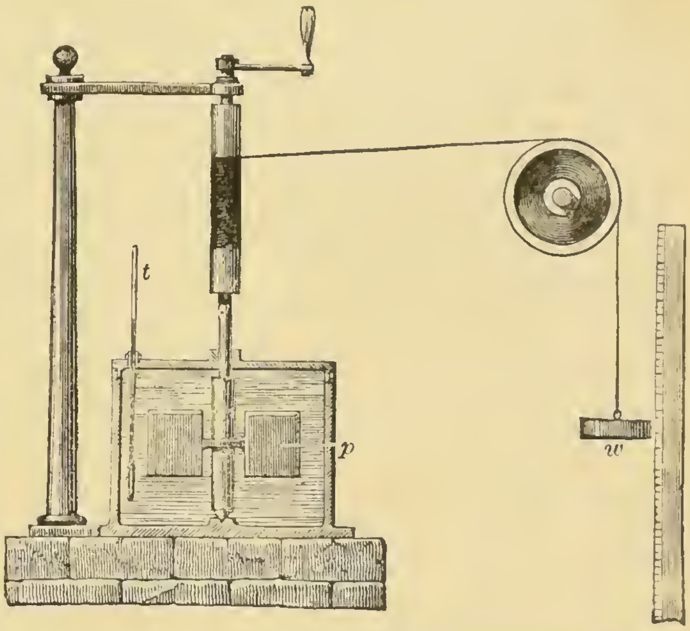

Fig. 190.—Joule's Apparatus for the Determination of the Mechanical Equivalent of Heat.

It consisted of a box in which, fixed to an axle, was a set of eight small paddles (*p*). The axle projected out of the box and had wound round it a cord, which passed over a drum, and connected to the cord was a certain weight (*w*). When the weight was allowed to fall, the drum revolved, the axle was turned and with it the paddles in the box. The box contained a weighed quantity of water, the temperature of which was taken. The revolving paddles agitated the water. A thermometer (*t*) fitted into the box dipped into the water. If the water became warmer the thermometer indicated the amount of heat. Joule allowed the weight to fall, causing the water to be churned, and then he found that, by the churning, the water was warmed. That is to say, the energy liberated by the falling weight, was transformed into the mechanical work of the revolving paddles, and that again was transformed into the energy of heat. Joule found that by a weight of 1 lb.

falling 772 feet, 1 lb. weight of water was raised one degree in temperature. That is to say, 772 units of work, or foot-pounds, were equal to 1 unit of heat or 1 calorie. We have seen that the energy liberated by a weight of 1 lb. falling 772 feet is the same amount of energy as is expended in raising 1 lb. 772 feet high. So that we might put the result thus: the amount of energy which, appearing as heat, will warm 1 lb. of water by 1 degree Fahrenheit, will, if converted into mechanical work, raise 1 lb. weight 772 feet in the air, or, what is the same thing, will raise 772 pounds 1 foot high. This number 772 is, therefore, called the **mechanical equivalent of heat.** In short, 1 unit of heat is equal to 772 units of work. If, then, a certain mass of coal yields 10 heat units, we can tell how much work it represents. Multiply by 772. The energy stored up in the coal, if all converted into mechanical work, will raise 7720 pounds 1 foot high, or 1 pound 7720 feet high. Similarly, if the weight of a ton has been raised 10 feet high, we can tell how much heat that represents. One ton is equal to 2240 pounds. That has been raised 10 feet, so that 22,400 foot-pounds of work have been done. But 772 foot-pounds are equal to 1 heat unit. Therefore 22,400 divided by 772 will give the amount of heat, in heat units, represented by the raising of the ton weight. It is equal to fully 29 heat units.

Here, then, is a means of determining the amount of energy stored up in any substance, such as coal, wood, oil, &c. It is only necessary to burn a given weight of the substance, say 1 pound, and to find how much water the heat produced will warm by 1 degree Fahrenheit. The figure obtained expresses the units of heat, or calories, yielded by the substance, and this, multiplied by 772, gives the mechanical work which the energy stored up in the 1 lb. of substance might perform, *supposing all the heat could be converted into mechanical work.*

Now, various observers have determined by experiments the amount of heat given off from very many different substances, so that there are now ready to one's hands the means of determining the value of these substances for the doing of work. The method by which the results were obtained it will be interesting to note. The instrument used to determine the amount of heat given off by a body in burning is called a **calorimeter**, or measurer of heat. It is represented in Fig. 191. It consists of a small chamber (C) within a much larger one (D). The space between the two chambers is filled with water, the quantity of which is measured. A thermometer (*t*) dips into the water to indicate the temperature. In the inner chamber is placed the substance to be burned. The heat given off in the process of burning is communicated to the water, various careful arrangements being made to prevent it being otherwise lost. When all the substance has been burnt, the temperature of the water is read off, and as the quantity of water is known, the units of heat are readily ascertained. It has been determined by such means that 1 lb. of wood charcoal, if completely burned, will yield 8080 heat units, that is will raise the temperature of 8080 pounds weight of water by 1 degree Fahrenheit. This heat we have seen is the result of the chemical union of the carbon, of which charcoal consists, with oxygen. Now, there is a gas called hydrogen, which, when chemically combined with oxygen, forms water. This gas burns. It is its presence in ordinary coal-gas that makes the gas burn. When hydrogen is burned with a stream of oxygen a flame of most intense heat is produced. It is this flame directed on a cylinder of lime that gives the intense light, the lime-light, so commonly used for magic lanterns. One pound weight of hydrogen when completely burnt yields no less than 34,460 units of heat.

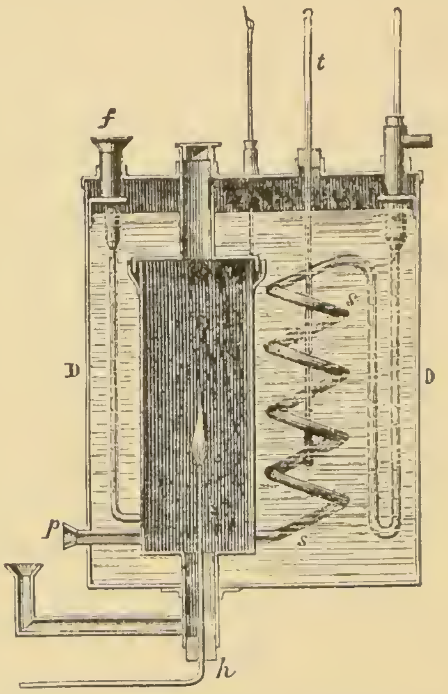

Fig. 191.—Dulong's Calorimeter for Combustion of Gases. The gas to be burned enters by *h*, oxygen for combustion by *f* or *p*, and the products of combustion pass off by the worm *s*, *s*.

We see, then, what an enormous quantity of heat is given off by carbon and hydrogen, and we have learned how, from the quantity of heat, we can determine the value of these substances for the production of mechanical work. Any-one who thoroughly understands this is provided with the means of estimating the value of different substances used as food-stuffs.

Food as a Store of Energy.—In the previous paragraphs it has been necessary to notice that fats, oils, starches, sugars, are built up by the plant out of chemical elements, which they obtain from the atmosphere and also from the soil. Now these different kinds of food-stuffs all consist of three elements, carbon, hydrogen, and oxygen, but arranged and combined in a highly complex way. We have seen, moreover, that the building up of these elements implies the expenditure of energy, and that the energy expended in the process is stored up in the manufactured substances. If these substances be broken down and reduced to their elementary form, the stored-up energy will be liberated. This breaking down can be effected by the process of oxidation or burning, by which the carbon unites with oxygen to form carbonic acid gas, and the hydrogen unites with oxygen to form water. The oxygen contained within the substances themselves is used for the process, but is not sufficient, and more requires to be supplied from without. In the oxidation process, whether it takes place rapidly or slowly, the stored-up energy is released in the form of heat, and from the quantity of heat liberated can be estimated, in the way already described, the value of the food-stuff for the production of mechanical work. This is true not only of the fats, starches, &c., that may be stored up in a plant, which, from one point of view, may be considered as something apart from the body of the plant itself, but is true also of the tissue of the plant itself, of the living matter or protoplasm of the plant, within which the living processes of the plant are accomplished. The protoplasm or living tissue of plants, as of animals, consists mainly of four elements, the three already named, carbon, hydrogen, and oxygen, and another of infinite importance, nitrogen, along with sulphur and sometimes phosphorus. If a plant be burned, the protoplasm becomes oxidized into carbonic acid gas, and water, and also into ammonia, the ammonia containing all the nitrogen, which had existed in the organized matter of the plant, the oxidation being accompanied as before by the liberation of energy in the form of heat. Animals feed on plants, some of them exclusively, and build up the compounds found in the vegetable food into still more complex substances in their own body, forming thereby muscle, blood, bone, fat and so on. Part of the food is never built up into the body of the animal, but stays in the body only long enough to be broken down into simpler and unorganized bodies, in order that the energy contained within it may be liberated for the use of the animal. Man consumes as food both vegetable and animal structures, uses it partly to build up the structure of his own body, and breaks part of it down into elementary substances in order to obtain from it the stored energy it contains. Food, then, whether animal or vegetable, consists of elementary substances built up into complex forms, and the energy which it thus contains may be liberated as heat by the process of burning. Various experiments, conducted by Professor Frankland, of the Royal School of Mines, and others, have been carried out for the purpose of accurately determining the value of different food-stuffs for mechanical work by the amount of heat liberated from them in process of combustion. The method adopted was that of the calorimeter already described. The following table gives the results obtained by Frankland. It expresses the amount of heat in heat units obtained by completely burning in the calorimeter 1 lb. of each substance named. The food-stuff was employed in its natural condition, that is without previous drying, unless when stated to the contrary.

NAME OF FOOD-STUFF.	Heat units per lb.[1]
Cod-liver oil,	9107
Butter,	7264
Cocoa nibs,	6873
Cheese (Cheshire),	4647
Bread-crust,	4459
Oatmeal,	4004
Flour,	3936
Pea-meal,	3936
Arrow-root,	3912
Ground rice,	3813
Yolk of egg,	3423
Lump-sugar,	3348
Commercial grape-sugar,	3277
Hard-boiled egg,	2383
Bread-crumb,	2231
Ham (boiled),	1980
Mackerel,	1789
Beef (lean),	1567
Veal,	1314
Guinness's stout,	1076
Potatoes,	1013
Whiting,	904
Bass's ale,	775
White of egg,	671
Milk,	662
Apples,	660
Carrots,	527
Cabbage,	434

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[1] Frankland used the French thermometric scale, the Centigrade scale. To heat 1 lb. of water by 1° on the Centigrade scale requires 1389 units of work, while, as we have seen, 772 is the figure for the Fahrenheit scale. To convert heat units on the Centigrade scale, therefore, *multiply* by 1389, and to convert units of work into heat units on the same scale *divide* by 1389.

By performing the appropriate calculation we might express the value of the energy liberated from each substance in terms of mechanical work. Thus from these figures we find that the total energy liberated from 1 ounce of butter would, if all could be converted into mechanical work, raise 281 tons 1 foot high.[1] Other illustrations are given in the table.

1 ounce of	butter is equal	to	281	tons raised 1 foot.
,,	oatmeal	,,	152	,,
,,	beaf (lean)	,,	55	,,
,,	milk	,,	24	,,
,,	carrots	,,	20	,,
,,	cabbage	,,	16	,,
	&c.		&c.	

If one carefully examines this list, one or two points of great interest speedily reveal themselves. The first glance shows that fats and oils head the list, they yield the greatest amount of energy. Cocoa nibs rank very high; but when we examine the composition of cocoa nibs we find they contain 50 per cent of fat, so that it is really because of their contained fat that they have so great value as stores of energy. Next to the fatty substances come the starchy. Arrowroot consists mainly of starchy material, while flour consists of starch to the extent of nearly 75 per cent, and meal to 63 per cent. If we ask how oatmeal has a higher value than flour or arrow-root, the answer is that oatmeal contains also 10 per cent of fat, while flour contains less than 1 per cent, and arrow-root contains none. It is, then, the fat in oatmeal that causes it to rank above flour, &c., as a store of energy. Again look at the difference between yolk of egg alone and the whole egg in the amount of energy they yield. Here again it is a question of fat. In the yolk of egg there is 30 per cent of fat, but when one takes white and yolk mixed, as the white contains no fat, the percentage of fat in the whole is reduced to 11. Thus 1 lb. of yolk is of more value, as a store of energy, than 1 lb. of mixed white and yolk. It is a similar circumstance that gives to mackerel a higher value as a store of energy than is possessed by whiting. Mackerel contains fully four times the quantity of fat that whiting does. Thus the list shows that, regarding food-stuffs as stores of energy, fats take the highest rank, starchy and sugary food-stuffs come next, and meaty substances (lean beef), &c., are poorer in the amount of energy they yield than either. This has been further shown by the results of actual experiments on dogs, in which it was found that

100 parts of fat yielded as much heat and energy for work as
232 ,, ,, starch,
234 ,, ,, cane-sugar,
and 243 ,, ,, lean meat.

Is there any reason for this high value of fat as a source of energy? When fat is analysed it is found that of every 100 parts

79 consist of carbon, and
11 ,, of hydrogen

and only 10 of oxygen. That is 90 of the 100 parts are combustible or oxidizable substances. Starch, on the other hand, contains in every 100

45 parts of carbon and
6 ,, of hydrogen,

a total of 51 parts only of combustible substance, the remaining 49 consisting of oxygen with which the burning is partly effected. Sugar consists of

43 parts carbon, and
6 ,, hydrogen

in the hundred, a total of 49. The enormous quantity of heat liberated by the burning of carbon and hydrogen has been already indicated (on p. 530), and when we find fat containing 90 parts in 100 of these elements as against 51 in starch and 49 in sugar, the reason of the high value of fat as a source of energy is apparent.

Now it will naturally occur to everyone, who considers the figures that have been given, that the amount of energy represented as mechanical work given off, from the burning of the food-stuffs named, is too great for belief. It seems absurd to think that 1 ounce of butter will yield heat, which, if transformed into work done, will raise 281 tons 1 foot high. The amount of heat stated is actually given off, and has been determined, as stated, by actual experiments in the calorimeter. In estimating the mechanical work that heat represents, it has been assumed that *all the heat is transformed into mechanical work*. But, as a matter of fact, no engine has been devised, or can be devised, capable of utilizing all the heat obtained from the burning of the fuel, and converting it into mechanical work. In the most perfect machine yet constructed it has been found possible to convert only $\frac{1}{8}$th part of the heat into work. It is the aim of engineers to construct engines that will utilize as much of the heat as possible, and yet this is the best result they have obtained. They do not wish the engine to become heated, for that means wasting the energy of the fuel. In the animal body the energy derived from food is converted into mechanical work to a much greater extent than can be effected by any steam-engine. It has been estimated, for example, that the horse can transform 32 per cent of the energy obtained from food into work, that the ox can transform 43 per cent, and man can transform 53 per cent. So that in this respect the human body is far ahead of the most perfect engine that man has yet been able to construct. But, in the case of the animal body, the energy of food that appears as heat, and is not transformed into work, is not lost. It is necessary to heat the animal body and to maintain its warmth at a certain degree, which is usually higher considerably than that of the external temperature. Because the body is continually in contact with an atmosphere colder than itself, a large quantity of heat is continually being given off from the body. Heat is constantly being lost in the evaporation of the sweat, in heating the air given out from the lungs, in heating the discharges from the body, &c. The quantity of energy consumed in this way, in 24 hours, has been calculated as equal to 2,839,000 units of heat, or a heat sufficient to raise about 62 pounds of water from freezing-point to boiling point (Gamgee). But energy is not only being constantly expended in the body in this way, it is also being expended in large amount in doing work of which there is no external sign. The heart is regularly contracting, driving the blood through the body. The work it does "might be estimated without exaggeration as at least equal in 24 hours to the work expended in lifting 120 tons to the height of 1 foot, while almost certainly it would greatly exceed this estimate. That is to say, that the heart of a person, who is almost absolutely at rest, does an amount of work which is a sensible fraction of the *external*, or, to use a popular expression, the *manual* labour performed in the working day of a hard working labourer." Over and above this, there is the work being regularly done by the muscles of respiration in expanding the chest against considerable resistance. If all these things are taken into account, it will become apparent that there will not be left over a very large balance of energy derived from the food for the performance of external work. Moreover, one must not forget that when a man simply walks about he is transporting the weight of his body, and when he walks up a stair he is raising the weight of his body so many feet into the air. Thus a man weighing 11 stones (154 lbs.) going up a step 6 inches high, does 77 foot-pounds of work in carrying up his body, and if he goes up a stair of 12 steps 20 times a day, in this exercise alone he does 16 foot-tons of work. The same man in walking one mile does nearly 17$\frac{3}{4}$ foot-tons of work in the mere transporting of his own weight.

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[1] 1 lb. of butter gives 7264 heat units. To get the equivalent in mechanical work, multiply by 1389. The result is 10,089,696 in foot-pounds per *pound* of butter. That is equal to 630,606 foot-pounds per *ounce* of butter. 630,606 divided by 112 expresses the same amount in hundredweights, namely 5630; and that again divided by 20, expresses the amount in foot-tons, namely 281.

All this time we have been arguing from figures derived from the burning of food-stuffs in the calorimeter. It is time now to say that it appears that food-stuffs undergo a precisely similar change in passing through the body to that they undergo in the calorimeter. The change, that is the combustion or oxidation process, as carried on in the calorimeter, is very much more rapid than the change as accomplished in the body, but the results are the same. Fats, starches, and sugars, are burnt to carbonic acid gas and water in the body, just as they are outside of the body, and the carbonic acid gas and water are, thereafter, expelled from the body as waste products. Whether the process be rapid or slow, the total energy liberated, when the process has been completed, is the same. The figures derived from the calorimeter may, therefore, with perfect propriety, be applied to the human body. There is an exception. Meat does not undergo complete combustion in the body. The figures obtained from the experiments are, in consequence, too high for it. Corrections for this are, however, easily made. This it is not necessary for us further to consider.

Now we must return once more to the illustration with which this section opened. We said the human body could be compared to a steam-engine in thorough working order, and that to maintain it in good condition it was necessary (1) for the tear and wear of its parts to be maintained, and (2) for energy to be imparted to it for the doing of work. We have seen that the energy is derived from the combustion of coal in its furnace. This induced us to consider the nature and sources of energy, and we naturally went on to consider food as a source of energy to the human machine, for the human body may also be viewed as a machine for doing work. In the doing of work some of its parts are subject to tear and wear, which, if the human machine is to be kept in good working order—that is, in good health—must be speedily repaired. In the second place, it must be supplied with energy.

This, then, is the twofold business of food, (1) to repair the tear and wear of the human machine, and (2) to yield energy by which it may do its daily work. Having seen, generally, how food is fitted to yield energy, we must next notice how food is fitted to repair tear and wear. Suppose a steam-crane is engaged lifting heavy loads for an hour on end. During the process two things have happened; (1) steam has been allowed to escape from the boiler into the cylinder to work the piston—that is, energy has been liberated, and to a slight extent—a very slight extent—the working parts of the machine have been worn. The energy for lifting the weight has not been obtained from the wear and tear of the machine, but from the steam. Now substitute a man for the steam-engine, and suppose him to work for an hour on end wielding a heavy hammer. He has lifted the hammer regularly by the repeated contractions of some of the muscles of his arm, and in these muscles two things have happened; (1) energy has been liberated within the muscles by the combustion or oxidation or burning of some substance contained in the muscles, and (2) the muscles, to a slight extent—a very slight extent—have been worn. That is to say, while the muscles have actually suffered some wear and tear by this work, the energy liberated in the muscles need not have been produced by the breaking down of some of the actual fibres of the muscle, but only of some substance contained within the muscle. It is plain, then, that there may be some considerable difference between supplying the material out of which energy is obtained and the material out of which the wear of the muscle is repaired. Whether there be any difference or not, there is only one source from which both kinds of material are obtained, and that source is food supplied. It is also perfectly plain that if the food supplied is to be sufficient for the rebuilding of wasted muscle, it must contain all the materials of which muscle is found to consist. The same is true of every other part of the body. In the working of the bodily machine the bones suffer some tear and wear. It may be slight, but the wear and tear, nevertheless, occur, and the food supplied must contain the elements of which bones are made. Nerves suffer waste, and every tissue of the body; and thus food must contain all the elements of which every organ and tissue of the body are built up. If it does not, some tissue of the body will not be supplied with material for repairing its wasted portions, and a catastrophe will, sooner or later, occur. In order to understand what kind of food is fitted for such purposes, we must, therefore, have some kind of knowledge of the composition of the human body.

THE CHEMICAL COMPOSITION OF THE HUMAN BODY.

Chemical Elements found in the body.—All the various complex substances found in nature can be reduced by chemical analysis to simple substances, and when they have been reduced to their simplest forms and cannot be any further split up, there remain seventy elements. By combinations of these seventy elements, of various kinds and in various proportions, all the substances known to exist in the world of nature are built up.

A human body, when dead, may be submitted to chemical examination just as a handful of earth, a piece of rock, or any other substance may be. When that has been done it is found that blood, muscle, nerve, bone, skin, hair, teeth, &c., may also be reduced to similar elements—that, in fact, the human body is built up of a few of the same seventy elements that are found in nature. Of the seventy elements only fourteen are found in the human body, namely, **oxygen, hydrogen, nitrogen, chlorine, fluorine, carbon, phosphorus, sulphur, silicon, calcium, potassium, sodium, magnesium, and iron.** Some of these elements, as they exist in their elementary form, are gases, others are metals, while the remainder are non-metals. This may be shown as follows:—

Elements found to exist in the Human Body.

Oxygen	Gases.
Hydrogen	
Nitrogen	
Chlorine	
Fluorine.	
Calcium	Metals.
Potassium	
Sodium	
Magnesium	
Iron	
Carbon	Non-Metals.
Phosphorus	
Sulphur	
Silicon	

Besides these, excessively minute quantities of other elements, such as manganese, copper, lead, &c., have been found, but probably they are only accidentally or temporarily present, and did not enter into the actual constitution of the body. They may, therefore, be neglected. Silicon is in a similar position though it appears on the list.

It is interesting to note the proportion in which these various elements are present, and that is shown in percentages in the following table:—

Oxygen	62·430	per cent.
Carbon	21·150	,,
Hydrogen	9·865	,,
Nitrogen	3·100	,,
Calcium	1·900	,,
Phosphorus	0·946	,,
Potassium	0·230	,,
Sulphur	0·162	,,
Chlorine	0·081	,,
Sodium	0·081	,,
Magnesium	0·027	,,
Iron	0·014	,,
Fluorine	0·014	,,
	100·000	

Oxygen, hydrogen, and nitrogen, as we see from the preceding table, are gases in their uncombined state, and yet they form three-fourths of the weight of the whole human body. Carbon is a solid. Charcoal, lampblack, black-lead, are impure forms of it. It forms more than a fifth of the whole weight of the body. Carbon and the three gases named thus form over 96 per cent of the total weight of the body.

Chemical Compounds found in the body.—It is necessary very carefully to note that, with slight exceptions, none of these elements exist *in their elementary form* in the body; they are combined with one another in various ways and proportions to build up more or less complex substances, differing widely from the elements of which they consist. The slight exceptions are oxygen, hydrogen, and nitrogen. Though the bulk of all three exists in combinations of various kinds, yet a small quantity of oxygen exists uncombined, but in solution, in the blood, a small quantity of nitrogen is also found in solution in the blood, and small quantities of all three exist free in the intestinal canal.

Water.—Now oxygen and hydrogen unite to form water; and water is found in the human body to the extent of over 60 per cent.

Inorganic Salts.—Further, a large number of the elements named are found uniting with one another to form inorganic salts, salts found existing in nature, which do not need the agency of any living thing, any organized structure, to cause them to combine, but do so simply by the force of chemical affinity.

The best example of this kind of compound is common salt, a compound of sodium and chlorine, called, therefore, in chemical language, chloride of sodium. It is found in all the tissues and fluids of the body, and is one of the most important inorganic substances the body contains, and is absolutely necessary for continued existence.

Chlorine, besides uniting with sodium, forms a salt in conjunction with potassium, the chloride of potassium, and forms, with nitrogen and hydrogen, the chloride of ammonium, ammonia being a compound of nitrogen and hydrogen. These are found in the body.

Other salts are found in the body, of great importance being those formed by a combination of phosphorus with sodium, with potassium, with calcium, and with magnesium, forming the phosphate of sodium, phosphate of potassium, phosphate of magnesium, and phosphate of calcium (phosphate of lime). This last, phosphate of calcium (that is, phosphate of lime), is the most abundant of the salts of the body. It forms more than half of the bones, and is found in considerable quantity in teeth, and it exists in other solids and in fluids of the body. It is present in milk to the extent of 2½ per cent. Associated with it in bones and teeth is a compound of calcium with carbon and oxygen, carbonate of lime.

Sodium combined with carbon and oxygen exists in the body as carbonate of sodium, and with sulphur and oxygen as sulphate of sodium.

Potassium also exists as sulphate of potassium.

Fluorine and calcium are found united as fluoride of calcium in the bones and teeth, though in very small amount.

If all these compounds, forming salts or mineral matters, that exist in the body, be summed up together, they are found to constitute about six per cent of the whole body weight.

Thus, so far as we have gone, we see the human body consists of:—

Water about	61	per cent.
Salts or Mineral Matters ...	6	,,

Namely—*Chloride of Sodium.*
,, of Potassium.
,, of Magnesium.
,, of Ammonium.
Phosphate of Lime.
,, of Sodium.
,, of Potassium.
,, of Magnesium.
Carbonate of Lime.
,, of Sodium.
Sulphate of Potassium.
,, of Sodium.
Fluoride of Calcium.

A compound of hydrogen and chlorine, hydrochloric acid, is found existing as such in the digestive juice of the stomach.

Organic Compounds.—Now, over and above these substances, there exists in the human body a series of compounds not found in the lifeless or inorganic world, substances formed of the union of the same elements that have been named, but which require for their compounding the agency of living structures. For that reason these compounds are called **organic.** Moreover, man and the lower animals cannot compound them, or build them up from the elements. That is done by plants. Man and the lower animals take the organic materials they require from the vegetable world, and so the structure of the animal kingdom, including man as the most imposing portion of the edifice, rests upon the vegetable kingdom as its foundation. The organic materials which animals and men take from the vegetable kingdom they build up into still more highly organized forms in their own bodies.

The organic materials found in the human body fall principally into three classes:—

Proteid or Albuminous Substances.
Carbo-hydrates (that is, Starches, Sugars, and Gums).
Fats.

The elements built up into proteids are carbon, hydrogen, oxygen, and nitrogen, with sulphur; the elements built up into carbo-hydrates are carbon, hydrogen, and oxygen; the elements built up into fats are also carbon, hydrogen, and oxygen. The important distinction between the first and the other two classes is that proteids contain the element nitrogen which the others want. Proteids are, therefore, called **nitrogenous,** and the others **non-nitrogenous** substances.

Further it will be noted that both the carbo-hydrates and the fats are built up of the same three elements, carbon, hydrogen, and oxygen. Though formed of the same three elements, these two classes differ markedly from one another. The difference between the two consists, for one thing, in the very widely different proportions in which the elements are combined in the two kinds of food-stuffs, a difference which chemistry can reduce to figures. But it also consists in the manner in which the elements are combined, just as stone, wood, and lime may be built up into two houses of very different form, and not the least resembling one another. It may now be convenient to put in tabular form the knowledge thus far gained.

The human body contains thirteen elements built up into various compounds, as follows:—

		Built up of
Inorganic—		
	Water	Hydrogen and Oxygen.
	Salts	Hydrogen, Oxygen, Nitrogen, Carbon, Calcium, Phosphorus, Potassium, Sodium, Sulphur, Chlorine, Magnesium, Iron, Fluorine.
Organic—		
Nitrogenous.........	Proteids ...	Carbon, Hydrogen, Oxygen, Nitrogen, Sulphur.
Non-nitrogenous	Carbo-hydrates	Carbon, Hydrogen, Oxygen.
	Fats	Carbon, Hydrogen, Oxygen.

We must consider the organic substances for a little.

Proteids consist, as already mentioned, of carbon, hydrogen, oxygen, nitrogen, and sulphur. The type of proteids is egg albumin, white of egg. These proteid or albuminous bodies are found in muscle, in nerve, in glands, in blood, and in nearly all the fluids of the body. The albuminous body of muscle is called **myosin,** that of the fluid part of blood is **serum-albumin,** that of coagulated blood is **fibrin,** the red corpuscles of the blood are formed of **hæmoglobin,** which contains an albuminous body.

Milk contains two albuminous bodies, the chief of which is **casein,** which forms the curd, and is the main constituent of cheese. Proteid bodies occur in various forms in vegetable structures; the proteid of cereals, wheat, corn, &c., is called **glutin,** that of peas is **legumin.**

Other forms of proteids exist. Thus, in bones, and connective tissues like tendon and skin, a proteid body exists which, on boiling, yields **gelatin.** Gristle (cartilage, p. 23) yields another proteid called **chondrin.**

Of proteid substances a human body is estimated to yield on an average about 18 per cent.

Carbo-hydrates are formed of carbon, hydrogen, and oxygen, the last two being in proportions to form water. Starch is a carbo-hydrate, and is found in the body in the form of **glycogen** or animal starch, supposed to be formed by the liver (see p. 147). Sugar is another of this class, and is found as **grape-sugar** in blood and liver, **muscle-sugar** or **inosite** in muscle, and **lactose** or **milk-sugar** in milk.

This class exists largely in the vegetable kingdom. Thus potatoes, rice, sago, &c., consist largely of starch. Sugar is found in fruit as **laevulose**: there is **grape-sugar**, of which honey mainly consists, derived from the sweet juices of fruits and flowers, and **cane-sugar. Gum** and **cellulose**, obtained from plants, are also carbo-hydrates.

The carbo-hydrates in the body are estimated at a fraction of one per cent of the total body weight.

Fats are formed of carbon, hydrogen, and oxygen, in which the two latter are not in proportions to form water. There are three kinds of fat in the body—**stearin**, of which ordinary tallow candles are made, **olein**, the chief ingredient of olive-oil, and **palmitin**. The fat of the human body consists of a mixture of these three, and is liquid at the ordinary temperature, the olein keeping the other two in solution.

The body of an average man contains about 16 per cent of fats.

Now, while it is said that a human body consists of so much water, so much salts, so much proteid material, so much carbo-hydrates, and so much fat, it is not to be supposed that these exist in a condition easily separable from one another.

Take a piece of the red flesh (muscle), it does not only contain proteids but also water, salts, carbo-hydrates, and fats. They are blended or mixed together, as it were, in the muscle, and in different cases the amount will vary. Fat exists in the muscle even though it be not visible to the naked eye; the microscope will show minute fat cells (see p. 17) between and among the muscular fibres.

It requires to be noted that, though the proteids are the principal kind of nitrogenous substances existing in the body, they are not the only ones.

The ferments concerned in digestion, the ptyalin of the saliva (see p. 143), the pepsin of the stomach juices (see p. 143), &c., are nitrogenous also. The colouring matters of the body, that of the blood and red flesh, and those of the bile are also nitrogenous substances. Moreover, as a result of the tear and wear of the body, and the consequent breaking down of the tissues that constantly goes on, a variety of substances is formed from proteids also containing nitrogen. Thus there can be extracted from ordinary red flesh, by means of water, a variety of nitrogenous substances, of which kreatin, kreatinin, sarcin, are the names of some. On this account they are called **extractives**. It is the presence of some of these that gives to flesh its peculiar flavour. Two other important substances produced from the breaking down of nitrogenous substances, and containing nitrogen, are urea and uric acid, found in the urine. Though found in the body, they are to be regarded as unavoidable rather than necessary constituents, since they are the result of tear and wear. In nerve tissues, as another example, are found substances called protagon, cerebrin, &c., supposed to result from nervous activity, which are also nitrogenous. In the same way the changes undergone by sugars, fats, &c., in the body, produce a series of substances that need not be named here. Though constantly found, they are not essential constituents of the body.

Briefly, then, we may put the matter thus, the human body is composed of thirteen elements, built up into componnds. The compounds may be grouped into the following classes—water, salts, proteids, carbo-hydrates, and fats. These five classes of compounds, existing as such in the body, are called the **proximate principles** of the body, and the proportion in which they exist is summarized in the following table:—

Percentages of Proximate Principles in the Body.

Water, ...	61·0	per cent.
Salts, or mineral matters, ...	5·5	,,
Proteids, ...	18·0	,,
Carbo-hydrates, ...	0·1	,,
Fats, ...	15·4	,,
Total, ...	100·0	,,

Or we might put it thus:—

The body of a man weighing 148 pounds will contain of

Water, ...	90·0	pounds.
Salts, ...	8·3	,,
Proteids, ...	26·6	,,
Carbo-hydrates, ...	0·1	,,
Fats, ...	23·0	,,
Total, ...	148·0	,,

THE NATURE AND CHEMICAL COMPOSITION OF FOOD-STUFFS.

In the paragraphs in which we have considered the constitution of the human body, we have really laid down the elementary conditions which all food-stuffs must fulfil if they are fitted to maintain the body in a healthy condition as a good working machine. We may now state these elementary conditions in as brief a manner as possible:

1. Food-stuffs must contain all the elements found built up into the various organs and tissues of the body, else they will not be sufficient to repair the waste going on in the body.
2. These elements are thirteen in number, chief among them being carbon, hydrogen, oxygen, and nitrogen.
3. The animal body cannot make use of these substances in their elementary form. The elements must be built up into compounds, more or less complex.
4. The elements are built up first by the agency of plants, acting under the influence of the sun's rays. The lower animals, used by man as food, consume plants, and build up the materials they contain into still more complex bodies. Then man uses both plants and animals as food, and builds up what they supply into the material, blood, bone, flesh, nerve, skin, &c., of his own body.

The Classification of Food-stuffs.—On page 536 it has been stated that all the tissues of the body, and nearly all the fluids, contain proteid substances in their composition, and that proteids, besides carbon, hydrogen, and oxygen, contain *as an essential element, nitrogen.* No food-stuff, therefore, which fails to contain nitrogen can be sufficient for repairing the tear and wear of the bodily machine. Besides, it has been pointed out (p. 530) that carbon and hydrogen yield, when burnt, enormous quantities of heat, that is to say, liberate large quantities of energy. So that food-stuffs, which consist mainly of carbon and hydrogen, and which contain no nitrogen, while quite insufficient for repairing wasted portions of the body, are most valuable for yielding to the body the energy for the performance of its work. Here, at once, we are provided with a principle of classifying the food-stuffs obtained from the vegetable and animal kingdom. Applying this principle we divide food-stuffs into

NITROGEN-CONTAINING or NITROGENOUS, to which belong **Proteids** — necessary for repairing tear and wear of the body.

and

CARBONACEOUS or NON-NITROGENOUS, to which belong **Sugars, Starches, Gums, Fats,** — specially valuable for the liberation of energy for work.

We must avoid the mistake, however, of supposing that nitrogenous food-stuffs are only useful for repairing tear and wear, and are always built up into the substance of the body. They contain, as we have seen, carbon and hydrogen, as well as nitrogen, and may thus be consumed in the body solely for yielding energy, without having previously been transformed into any of the living tissue of the body, muscles or bone or nerve, &c. All we assert is that muscle, bone, nerve, blood, &c., cannot be formed without them, since they only of food-stuffs contain the necessary element, nitrogen. This does not imply that they are always so built up. A quantity of proteid food may be eaten greater than is necessary to repair the tear and wear. In such a case the excess will undergo combustion in the body and will thus yield energy. Similarly we must not suppose that carbonaceous foods are used simply to yield energy, and are never built up in the body. For we have seen that the body contains a proportion of such compounds, and as they will also undergo waste they must be renewed from the food. What we do assert is that such substances yield energy in largest amount, and are the most useful forms of food material for the doing of work.

When we are reminded that the human body consists to a large extent of water, and to a small extent also of saline material or mineral substances, the necessity of these being present in food-stuffs is apparent. Thus the food-stuffs needed by man fall into the same five classes of compounds as the substances forming his body (p. 536). They are called the **proximate principles of food, or alimentary principles,** namely:

- **Inorganic**
  - 1. Water.
  - 2. Salines or Mineral Matters.
- **Organic**
  - 3. Nitrogen-containing or Nitrogenous. — Proteids
  - 4. Carbonaceous or Non-nitrogenous.
    - Carbo-hydrates — Sugars. Starches. Gums.
    - Fats

The Fate of Various Food-stuffs in the body.—It may not be uninteresting to state a few of the reasons which have led to the general conclusions that have been indicated. A brief consideration of the grounds of the conclusions will help to give a better appreciation of the relative value of the different foods, will supply the reasons for varying the kind of food taken under different circumstances, and will afford a more connected idea of the ultimate fate of the different foods in the body.

The Use of Water.—Regarding water not much more need be said. It undergoes no transformation in the body, we may say. But when we consider that the body loses daily about 10 ounces of water in the form of vapour given out in the breath, about 2 lbs. weight daily in the form of sweat from the skin, and from 50 to 60 ounces daily in the form of water given off from the kidneys, the need of replacing that loss is apparent. We shall see that all our food-stuffs contain a proportion of water in their composition, some of them consisting of water to the extent of three-fourths, and thus we are restoring water to the body with every bite we eat, as well as by the water we drink as such, or in beverages such as tea, coffee, &c.

The Use of Salines.—Salts of various kinds are also given off from the body in the perspiration (p. 309), in the excretion of the kidney, &c. (see p. 292), and they must be restored to the body.

The most familiar of the mineral substances we use in our food is common salt, or chloride of sodium (see p. 535). We know how wanting in pleasurable taste are most food-stuffs which are deficient in common salt, and how freely we add it to our food. There are, however, other saline substances always present in food-stuffs which are equally essential to the bodily well-being, though not required to the same amount. The process used in preserving food by pickling removes a considerable proportion of such saline substances from the food. If such preserved food forms nearly the exclusive diet for any length of time, serious effects on the health of the persons are produced. It is in such circumstances that scurvy appears among ships' crews. That this state of bad health is the result of the absence from the food of certain mineral substances is plain from the fact that if fresh vegetables, which are rich in the salines, be freely supplied, or in their absence other substances containing the salts, such as lime-juice, restoration of health results. A definite proportion, then, of saline substances in the food, seems necessary for the proper performance of the nutritive processes in the body.

The Use of Proteids.—The fate of proteids in the body was for a long time the subject of controversy. Liebig's view was that proteids were built up into the tissues of the body, into the flesh of muscle, &c.; and that when work was done it was done at the expense of the muscles, parts of which were broken down or underwent waste by the exertion, and thus proteid food was needed to repair this waste. If this were so it would imply that with increased work there would be increased waste of tissue and need for increased supplies of proteid foods, such as beef, fish, &c. It is extremely interesting to follow the steps by which the accuracy of this view was tested. Proteids, we have seen, are nitrogen-containing substances. If work is done at the expense of proteids then the nitrogenous waste of the body will be increased. Now, practically the only channel by which nitrogenous waste is expelled from the body is the kidneys, and it is expelled in the form of the nitrogenous body urea, the chief ingredient of the urine. If, then, work is done at the expense of proteids, at the expense of the tissues of the body, with increased work there will be an increased amount of urea expelled by the kidneys, and with less work there will be less urea expelled. In fact, the amount of urea expelled will depend on the amount of work done. This has been found not to be the case. Two German professors, named Fick and Wislicenus, made a direct experiment upon themselves. They ascended a mountain, 6561 feet high, and estimated the quantity of nitrogen given off as urea from the body during the period of their exertion, and they compared the quantity with the amount of urea given off from the body before the ascent began and after it was ended. In order not to cause errors by the kind of food taken, they ate no nitrogen-containing food for a whole day before the ascent, nor indeed any food of this kind till after the ascent was over, when they rested and took a liberal meal of meat, &c. The following is the result in the case of Fick :—

Before the ascent,		9·7	grains	nitrogen	per hour.
During	,,	6·3	,,	,,	,,
After	,,	6·1	,,	,,	,,
During the night,		6·9	,,	,,	,,

This shows that the work was not done at the expense of the tissues, else the quantity of nitrogen given off from the body would have increased. The fall in the quantity of nitrogen was due to the abstinence from nitrogenous food, and the increase during the night was in consequence of the meal containing nitrogen taken after the ascent.

This result has been abundantly corroborated by later experiments. Thus, a set of observations was made on a watchmaker in the Physiological Laboratory of Munich, who was placed under three conditions. In one of the observations he received for a time no food and did no work, in a second he received a liberal diet and did no work, and in a third he received a liberal diet and did hard work. The quantity of nitrogen in the food given was estimated, and the quantity given off from the body was noted. If the quantity given off exceeded that of the food, it meant waste of tissues, loss of flesh, and the amount of flesh lost could be calculated from the excess of nitrogen expelled from the body. If as much nitrogen was not expelled as was given in the food, the conclusion was that the balance had been built up in the body, that is, the man had gained flesh, and the gain could also be calculated. Fat is very rich in carbon, and from the quantity of carbon given in the food, and the quantity given out as carbonic acid in the breath, it could be decided whether the body had gained or lost carbon. If the quantity given out exceeded that introduced as food, it was interpreted to mean that some of the stored-up fat of the body had been consumed and the man had lost fat. If the quantity given off were less, it meant that some had been stored as fat, and the man had gained in fat. The results were as follows:—

During the period of—

No food and no work the man lost 11 ounces of flesh and $7\frac{2}{3}$ ounces fat,

Liberal diet, no work, the man gained no flesh, but $2\frac{1}{3}$ ounces fat,

Liberal diet, hard work, the man lost no flesh, but 2 ounces fat.

Work is, therefore, not done at the expense of the built-up tissues, but at the expense of carbonaceous compounds stored up, specially fat, but also carbo-hydrates, such as starch and sugar.

It appears, then, that a certain amount of tear and wear of the tissues goes on irrespective of what amount of work is done, and that this amount is not materially increased with increased work, even with hard work, so that if a certain quantity of proteid food is given per day, sufficient to repair the waste, all that is further needed is a quantity of energy-yielding food, such as fat, starch, and sugar, which should be varied according to the work done, that is, the energy expended.

Supposing more proteid food is given than is necessary to repair tear and wear of tissues, what happens to it? The excess undergoes direct combustion in the body without previous building up into tissue, and thus will yield energy and heat. It appears that some of the excess may even be transformed into, and stored up as, fat. For proteids consist, as we have seen (p. 536), of nitrogen with carbon, hydrogen, and oxygen. When proteid has been consumed in the body, the waste, as we have said, is urea, and the urea contains all the nitrogen that was present in the proteid, but it does not contain all the carbon or hydrogen. Two-thirds of the carbon and hydrogen do not appear with the expelled urea. It seems, then, that, in the body, when proteid is consumed or undergoes combustion, it splits up into two parts, one containing all the nitrogen and a third of the carbon and hydrogen, which is expelled as urea, and another part containing the remaining two-thirds carbon and hydrogen. If this remainder be not immediately consumed to yield heat and energy, it is surmised that it may be built up in the body and stored as a carbonaceous body, such as fat, or a carbohydrate, like glycogen (see p. 147). Thus dogs fed on lean meat may gain in weight by the laying on of fat, derived, therefore, from the proteid of the meat, since fat is not present to any extent in the diet.

It is of great importance to note further that if proteids are necessary for the repair of waste in the tissues, they are equally necessary for the building up of new tissues, as in the growing person, for the production of blood, the growth of muscle, bone, nerve, &c. So that, if an adult man needs only the quantity of proteid that will repair the wear of his tissues, which is not materially increased by his work, a child needs not only sufficient to repair the daily tear and wear, but also an added quantity for growth. *The child needs, then, a larger quantity of proteid in proportion than a full-grown person.* It is because this fact is not recognized that children are fed so largely on non-nitrogenous foods, starchy foods, such as arrow-root, corn-flour, &c. They thus fail to obtain enough nitrogen for the building up of new tissues, and are white-faced from deficient blood, have soft, flabby muscles, and weak, yielding bones.

The Use of Fats.—If experiments show that work is not done at the expense of the nitrogenous tissues of the body, they equally plainly show that it is done at the expense of fats and carbo-hydrates. The waste products of the combustion in the body of fats, starches, and sugars are carbonic acid gas and water, just as urea is the special waste product of the combustion of proteids. While the amount of urea is not increased by work, the amount of carbonic acid gas given off from the lungs is markedly increased. In the case of the watchmaker, already referred to, while the quantity of urea expelled was the same during the day of hard work as during the day of no work, the amount of carbonic acid gas expelled increased from 14,000 grains on the day of no work to 18,000 grains on the day of hard work. Moreover, if the body be in a cold atmosphere, the amount of carbonic acid given off again markedly increases, indicating an increased combustion of fats and carbo-hydrates to yield heat for the maintenance of the warmth of the body. For a similar reason fat is one of the chief articles of consumption in the Arctic regions. During starvation the fats laid down in the body are the first to disappear. It thus becomes certain that fats are consumed in the body for the purpose of yielding energy for work, and heat for maintaining bodily warmth; and they are, above all kinds of food, best fitted for such purposes. If an amount of fat is given in excess of what is required for these purposes, it is stored up in the body as fat, waiting till called for.

The Use of Carbo-hydrates (sugars, &c.).—As has been already indicated in the paragraph on Fats, the sugars and starches introduced as food undergo combustion in the body for liberating energy and heat, but they are less useful than fats for these purposes, and the explanation of that fact is given on p. 532. These kinds of food-stuffs may be stored up in the body, if not immediately needed, in the form of animal starch or glycogen, which is manufactured and stored in the liver, as explained on p. 147. Thus Dr. Pavy showed by a series of experiments, conducted on dogs, that by a diet of starch and sugar the size of the liver was greatly increased, and that the increase in size was due to the increased quantity of glycogen produced in it from the starch and sugar. It is possible that subsequently this glycogen, before being consumed in the body, undergoes a further conversion into fat. It has been certainly proved that sugars and starches become transformed into fat in the body, and, if not immediately required, are stored up as such. Thus two observers, Gilbert and Lawes, fattened pigs on a diet rich in carbo-hydrates and found that 472 parts of fat were laid down in the body for every 100 parts of fat contained in the food. The increase in the fat could have been effected only by a transformation of the starch and sugar of the food into fat. The wax of bees is a fatty substance, and Huber showed that bees produced wax when supplied with nothing but sugar. Then the delicacy known as *pâtê de foie gras* is made from the fatty livers of geese. The fatty degeneration of the liver is produced by stuffing the geese with a food rich in proteids and carbo-hydrates, and preventing exercise. The fat is, therefore, manufactured in the body from that which is not fat.

Sugars and starches, then, are consumed in the body for yielding energy and heat, while any excess is converted into glycogen or fat and stored till required.

We may represent these conclusions in the following table:—

Uses of the Various Food-stuffs in the Body.

WATER	Required by all the tissues. Daily supply needed to replace what is given off from lungs, skin, and kidneys.		
SALINES or MINERAL MATTERS	Enter into the composition of all the tissues, and promote their healthy activity.		
PROTEIDS	1. Build up tissues, muscle, bone, nerve, &c., in the growing person. 2. Repair the tear and wear of the tissues, constantly occurring, irrespective of work.	**Excess**	1. May be directly consumed to yield energy and heat. 2. Part may be stored up as fat till required. 3. Part may be stored up as glycogen.
FATS	Undergo combustion to yield (1) Energy for work, (2) Heat.	**Excess,**	Stored up as fat till required.
CARBO-HYDRATES (Sugars, Starches, &c.)	Undergo combustion to yield (1) Energy for work, (2) Heat.	**Excess**	Stored up as (1) fat, (2) glycogen.

The practical conclusions from these considerations have been already indicated, but will bear repetition.

There is a marked difference, in the proportion of the various kinds of food-stuffs, between the diet suitable for the full-grown person and that for the growing child.

As regards the full-grown man—

1. He needs a quantity of proteids sufficient to repair tear and wear of tissues. This quantity is, broadly speaking, the same from day to day, and is not materially affected by the amount of work done.
2. He needs a quantity of fats and carbo-hydrates, increasing (1) with increased work, in order to yield an increased amount of energy, and (2) in a cold climate or in cold weather, to yield an additional quantity of heat, and decreasing with lessened work or warmer weather.

As regards the growing person—

1. He needs a quantity of proteids sufficient to repair tear and wear of tissues.
2. He needs, over and above, a quantity of proteids for purposes of growth.
3. He needs fats and carbo-hydrates according to exercise, external cold, &c.

These facts show at once the great value of milk as a diet for children, and its much less value as a diet for adults. It contains a quantity of proteids, relatively large in proportion to the fats (cream) and carbo-hydrate (sugar of milk) it contains, and thus meets the wants of growing tissues, but the adult needs a larger proportion of the fats and carbo-hydrates, for the doing of work, than it affords.

Setting water and saline materials aside as being derived from the inorganic world, the world of lifeless matter, it will help us greatly in realizing the extent of the proteids, fats, and carbo-hydrates, derived from the organic world, if we now give a list of the most commonly known food-stuffs, indicating into which of these classes they fall.

NITROGENOUS OR PROTEID FOOD-STUFFS.

From Animal Kingdom.	From Vegetable Kingdom.
Butchers' Meat of all kinds.	Beans, Peas, Lentils.
Poultry.	Wheat, Oats.
Wild-fowl.	Flour and Oatmeal.
Game.	Rye, Barley.
Fish.	Indian Corn, Rice.
Shell-fish.	Potatoes.
Eggs.	Vegetables of all kinds.
Milk.	Fruits of all kinds.

NON-NITROGENOUS OR CARBONACEOUS FOOD-STUFFS.

Sugars.	Starches.	Fats.
Cane-sugar.	Sago.	Butter.
Grape-sugar.	Corn-flour.	Dripping.
Beet-sugar.	Arrow-root.	Lard.
Treacle.	Tapioca.	Butterine or Oleo-Margarine.
Golden Syrup.	Cassava.	Oils, such as Olive and Almond Oil, &c.
Honey.	Tois-le-mois	
Manna.		

Gums also belong to the Non-Nitrogenous class.

With the knowledge we have thus far gained, it is possible for us to make some broad general statements. Thus we can say that a diet which consisted almost exclusively of corn-flour, arrowroot, or sago would be entirely an improper diet because of its want of nitrogen, and of its consequent utter inability to yield material for building up wasted tissues. But such general knowledge as this is of very limited value. We can say that beef is nitrogenous, and is, therefore, a food-stuff that will yield the material for repairing the waste of the body. But besides nitrogenous or proteid material, beef contains other substances, and we have as yet no information that will enable us to judge how much nitrogen one pound of beef may contain, and how much of it will be necessary for a day's ration. We have as yet no means of saying whether beef or beans supplies the nitrogen in largest amount. In order to obtain this fuller information a complete analysis of the various food-stuffs is necessary. Such complete analyses have been made. They show that any one of the nitrogenous food-stuffs named in the above table is really a mixture of two or three, sometimes of all, of the classes of food material tabulated on p. 538. Thus beef is a mixture of water, mineral matters, fat, and nitrogenous material; milk is a mixture of water, saline matters, fat, carbo-hydrate in the form of sugar, and nitrogenous matter in the form of curd; oatmeal contains water, mineral matters, carbo-hydrate in the form of starch, fat, and nitrogenous material—some, that is to say, of all the different classes of food-stuffs; and so on. This is shown in a very striking way in Plate IX., where the composition of various animal and vegetable food-stuffs is represented by variously coloured bands. Each band represents 100 parts of the food-stuff, say 100 lbs., and it is divided by small marks above it into 100 equal parts. The portion of the band marked blue represents the amount of nitrogenous material in the 100 of the food-stuff. The yellow part of the band

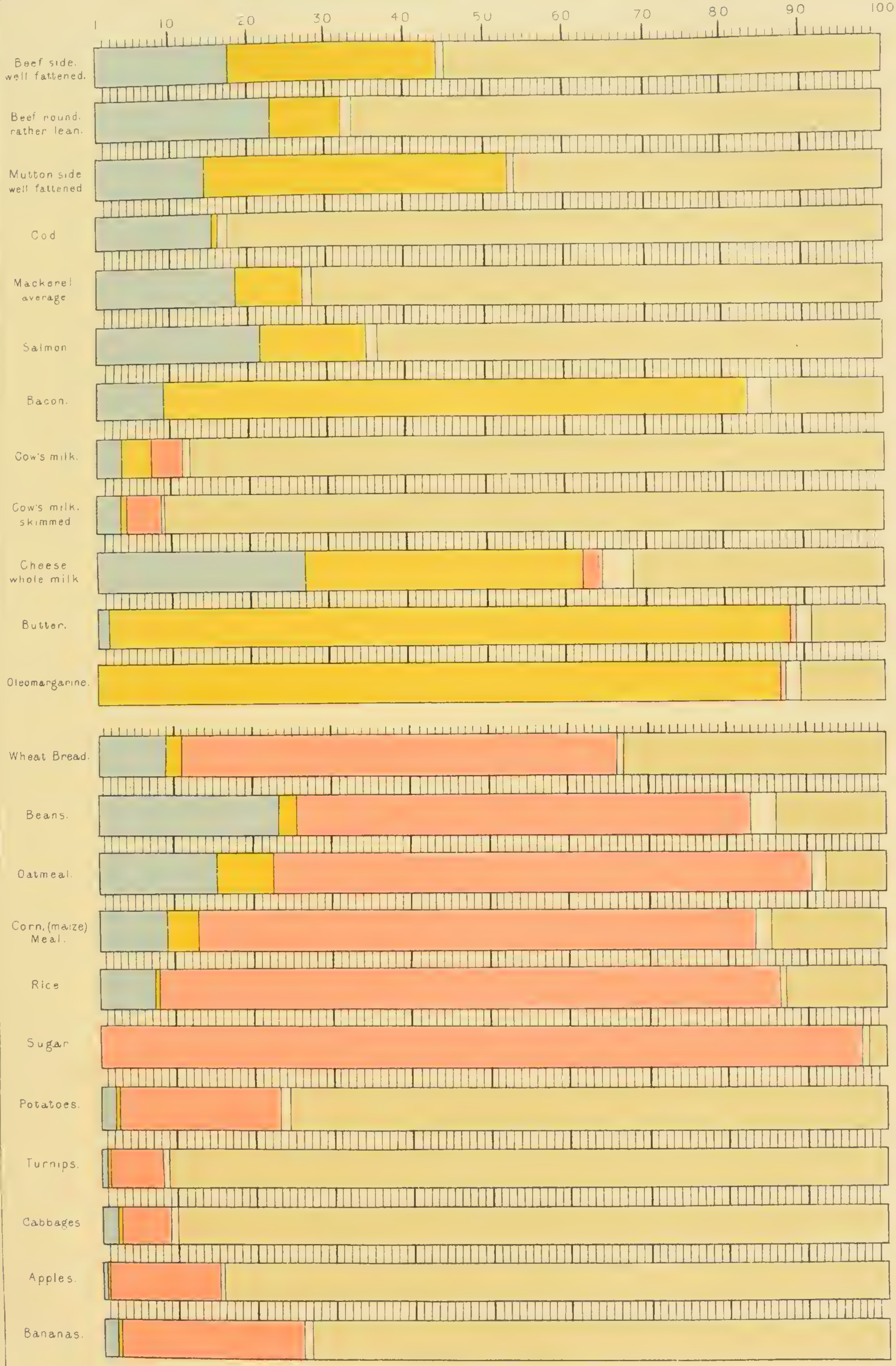
PLATE IX.—THE COMPOSITION OF FOODS.

Proteids or nitrogenous substances consist of carbon, hydrogen, oxygen, nitrogen, and sulphur. The type of proteids is white of egg. These proteid bodies are found in muscle, in nerve, in glands, in blood, and in nearly all the fluids of the body.

Carbo-hydrates are formed of carbon, hydrogen, and oxygen, the last two being in proportions to form water. Starch is a carbo-hydrate, and is found in the body in the form of animal starch. Sugar is another of this class of substances, and is found as **grape-sugar** in blood and liver, **muscle-sugar** in muscle, and **milk-sugar** in milk.

THE COMPOSITION OF FOODS.

Plate IX.



Each band represents the composition of 100 parts of the food-stuff. The fine lines between the bands are hundredths, and the fewer and darker lines are tenths. Each band is thus provided with a scale by means of which the proportion of each ingredient can be easily read off. The scale above the first band is numbered and by carrying the eye down the plate the number can be easily made to apply to the other bands also. Thus wheat-bread is seen to consist of proteids to the extent of 9 per cent. of fat to the extent of 2 per cent. of carbo-hydrates, (sugar and starch) to the extent of 55 per cent. of mineral matters 1 per cent. and of water 33 per cent. while butter contains about 1½ per cent. proteids, 87 per cent. fat, barely 1 per cent carbo-hydrates, 2 per cent. mineral matters, and rather over 8½ per cent water

Explanation of Signs.

🟦	🟨	🟥	☐	🟫
Nitrogenous. or Proteids	Fats.	Carbo-hydrates (Sugar & Starch)	Mineral Matters.	Water

represents the fat, the red the carbo-hydrate (which may be sugar or starch, or a mixture of both), the white portion indicates the saline, and the black the amount of water. To give a complete example. Beef, from the side, well fattened, contains 17·5 per cent proteid, nearly 27 per cent fat, something over 1 per cent mineral material, and fully 54 per cent water, no carbo-hydrate.

With such analyses as these our knowledge of food-stuffs ceases to be vague and general, and questions as to the best food for building up tissues and for liberating energy can be readily answered, while we are supplied with the means of comparing various articles of food and determining their relative value.

We shall, therefore, now proceed to go over the various articles commonly used as food, giving tables of their composition. After that we shall be able to discuss fully questions relating to diets—what quantities and kinds of food ought to be used by the average person per day, and to give details as to how a diet should vary in accordance with varying circumstances of age, sex, work, and climate, &c.

COMPOSITION OF ANIMAL FOODS.

I. Nitrogenous Animal Foods.

BUTCHERS' MEAT.

Percentage Composition of Meat.[1] (Letheby.)

	Lean Beef.	Fat Beef.	Lean Mutton	Fat Mutton	Fat Pork.	Veal.
Water, ...	72	51	72	53	39	63
Nitrogenous, .	19·3	14·8	18·3	12·4	9·8	16·5
Fat, ...	3·6	29·8	4·9	31·1	48·9	15·8
Saline,..........	5·1	4·4	4·8	3·5	2·3	4·7

An examination of the above table reveals some very interesting facts. It will be noticed, first, that the proportion of water present in meat is very much higher than would ordinarily be supposed. It varies from about 50 to about 70 per cent. That is to say, 4 lbs. of lean beef, if perfectly dried, will shrink to rather less than $1\frac{1}{4}$ lbs. The second readily observed fact is that there is a relation between the quantity of water and the quantity of fat. It will be seen that when the proportion of water is large the proportion of fat is small, and when the proportion of fat becomes large the amount of water is diminished. Thus fat beef contains 21 per cent less water than lean beef, but 26 per cent more fat. Fat, that is to say, displaces water. This is quite in keeping with the popular notion that very lean beef is not economical. At the same time an excess of fat is undesirable and wasteful; for then it cannot readily be made use of, and, as the table shows, taking equal weights of lean beef and fat beef, there is less nitrogenous material in the fat than in the lean. The fat ought not to be in large masses on the meat, but should be distributed throughout it, showing as white lines running through the beef, giving it a marbled appearance. The amount of fat laid down in an animal's body is dependent upon a variety of circumstances. The kind of feeding has a marked influence, and the mode of life affects the fattening process in a very marked way. Animals in the wild state do not fatten. Fat is not laid down in the body, because carbonaceous substances are consumed in the body for yielding the energy needed in the state of unrestrained freedom. It is estimated that of the total weight of an ox ready for the market one-third is fat, and that fat forms rather more than the same amount of the body of a sheep.

There is also a considerable difference between the flesh of young and of mature animals. As a rule, while the flesh of the young animal is more tender, it is less nutritious and less digestible. Specially is it likely to be less nourishing if the animal has been quickly fed for the market. Enough time has not been given to permit the development of the muscular fibre, which is, in consequence, flabby and insipid. On the other hand if the animal has been too old or has been used for work, the flesh is too firm and hard to make pleasant eating.

Beef is said to be at its best when cut from the carcass of a four-year-old ox, and wether mutton from a three-year-old is in the best condition.

There is an important point on which the table is silent, and on which, indeed, chemical analysis can give no information, and that is flavour. It depends upon the presence in the meat of a series of bodies, which, because they can be dissolved out by water, are called **extractives** (see p. 537). They are found in greatest abundance in the flesh of wild animals, and it is their presence in more than usual quantity that gives to meat the quality people speak of as "richness." It is because the flesh of young animals is so deficient in these bodies that it is poorer and less tasty than that of the mature animal. Flavour also varies with the animal, the flesh of each kind having its own peculiar character. It is influenced by the feeding, being best just before removal from green pasturage in the months of September and October; and it is diminished by artificial feeding. It is the natural feeding and the unrestrained life that give mountain-fed mutton the quality that makes it so desired. Turnip feeding imparts a particular kind of flavour.

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[1] These analyses differ considerably from those in Plate IX. The above are analyses of English samples, those of this Plate are American.

The analyses given in the table apply to meat without the bone, and if any calculation is made, by means of the table, of the various nutritive materials present in, say 1 lb. of beef, as bought for domestic purposes in the ordinary way, due allowance must be made for the inevitable piece of bone. It has been calculated that of a whole ox carcass bone forms from 10 to 20 per cent of the whole weight, but the amount varies according to the cut.

Thus joints seldom contain less than 8 per cent of the weight in bone.
The neck and brisket contains 10 per cent do.
The shin and legs 33 to 50 per cent do.

Thus the most economical parts are the round and the thick flank, next in order comes the brisket, and lastly the leg. In mutton and pork the leg is the most economical and then the shoulders.

Bone, however, is not an innutritious portion of the animal, provided the nutriment is properly extracted from it. Church gives an analysis of the bone of a mutton chop, showing the following ingredients:—

Water................	32·2	per cent or	5 oz.	66 gr. in 1 lb.
Nitrogenous.........	18·7	,,	2 ,,	434 ,, ,,
Fat.....................	9·0	,,	1 ,,	193 ,, ,,
Saline { Phosphate and carbonate of lime }	40·1	,,	6 ,,	182 ,, ,,
	100·0		16 oz.	

Smith, basing his calculation upon the analysis of shin-bones, estimated that

3 lbs. of shin-bones would yield as much carbon as 1 lb. of beef.
6 lbs. of shin-bones would yield as much nitrogen as 1 lb. do.

that is, the nutritive value of bone is as regards nitrogen $\frac{1}{6}$ that of beef, and as regards carbon $\frac{1}{3}$ that of beef. Bones vary in the amount of nutritive material they contain according to their form. Dense bone contains less animal and more mineral matter than spongy bone, and the more abundant the marrow the more useful the bone, for marrow consists largely of fat, and is therefore of value as yielding carbon for liberation of heat and energy. In order that the nutritive material may be properly extracted bones require grinding down. This could not be attempted for ordinary domestic purposes, but at any rate the bone ought to be well smashed up, to permit the extraction of as much nutriment as possible. The joint ends of bone yield, from the gristly material and from the tendinous and ligamentous parts about the joint, a substance which, on boiling, is converted into gelatine. It is this, perhaps, more than the nutritive material extracted from the bone itself, that makes the bone useful for the making of stock for soup.

Percentage Composition of Various Parts of Animals.

	Sheeps' Kidney.	Calves' Liver.	Tripe.	Foie Gras.	Bacon, fat salted and dried.
Water.........	78·60	72·33	67·1	22·70	13·9
Nitrogenous,	16·56	20·0	13·3	13·75	9·0
Fat............	3·33	5.58	17·1	54·57	74·1
Carbo-hydrate.	0·21	0·45	—	6·40	—
Saline.........	1·30	1·54	2·5	2·58	3·0

The above tables show the nutritive value of the various internal organs noted. There are, however, objections to their use, mainly on account of their being difficult of digestion. Thus the kidney is of a close texture, and unless skilfully cooked, so that all the juices are retained, it may be hard and with little flavour. The same objection exists to the use of the heart, which closely resembles ordinary meat in its composition, though it is much firmer and harder. The liver is rich and savoury when properly cooked, but easily rendered hard and tasteless, and is difficult of digestion. Comparison between the table of calves' liver and foie gras, the fatty liver of Strasburg geese (see p. 541), indicates how the kind of feeding followed in the case of the geese alters the composition of the organ. The table shows the fatty liver to consist of over a half of fat. Tripe used as food consists of the paunch, or first portion of the stomach of the ox or cow. Of considerable nutritive value, it possesses the great additional advantage of being the most easily digested of animal foods, and it is of very agreeable flavour. Sweetbread is, strictly speaking, the pancreas (see p. 142), but the organ sold by butchers under this name is specially the thymus gland (p. 205), and other glands, such as the thyroid (p. 205), are also sold under the same name. The thymus of the calf is the most esteemed. It is nourishing, and when properly cooked easy of digestion. The lungs or lights are eaten along with the liver, and though containing nutritious material are rather indigestible.

The blood of animals, chiefly the pig, is consumed in the form of black-puddings, which are made of a mixture of blood, groats, fat, and various herbs. The mixture is contained in a piece of skin from the intestine of the pig. Bacon belongs to the class of cured meats. The flitch is from the side. The process of curing consists in rubbing into the side a mixture of salt and saltpetre (nitre). Brine is also forced into the flesh by a force-pump. The sides, after being dressed in this way, are piled on one another for four days, then turned and sprinkled with salt, and allowed to lie for twelve days. After washing and drying they are hung in the smoke-house and submitted to the fumes of burning oak sawdust for three days, when they acquire the proper flavour and are ready for market. "For domestic use pork may be cured as follows: Stir some salt with hot water till no more of the substance is dissolved. This forms the brine or pickling liquor. Then mix, for a pig of moderate size, one pound of brown sugar and half a pound of nitre; rub this mixture well into the meat, which is then to be put into the pickle, remaining there two days. After this take it out and rub the pieces with salt alone. Return it to the pickle. It will be ready for use, after drying and smoking, in six or eight weeks" (Church). The small quantity of water contained in bacon makes it, weight for weight, of more nutritive value than fresh pork, while the pickling process renders the fat more digestible than it is in the fresh state. This is an exception to the general rule that curing renders meat less digestible. If the pickling has been too long continued, however, the lean portions will have become too dry by the abstraction of the juices. By noting in the above table the relative proportions of nitrogenous material and fat in liver and bacon, the meaning and advantage of combining these two in one dish becomes apparent, the one making up for the deficiencies of the other. The same is true of the combination of chicken and ham, for the flesh of fowls, as will be seen from the succeeding table, contains a very slight admixture of fat, while it is more than usually rich in nitrogenous material.

The same advantage is gained from a mixed diet of ham and eggs, veal and ham, bacon and beans, rabbit and ham, &c., the bacon or ham supplying in each case the fat, while the eggs, beans, veal, or rabbit yields in abundance the nitrogenous constituent.

POULTRY, GAME, AND WILD-FOWL.

Percentage Composition of Poultry and Game.

	Fowl.	Hare.
Water	73·15	74·35
Nitrogenous	22·65	23·34
Fat	3·11	1·13
Saline	1·09	1·18

The number of birds used as food, in various parts of the world, is very great. The analysis of the common barn-yard fowl may be taken as a fair sample. It will be noticed that the proportion of fat is small, and the proportion of nitrogenous material large, the latter existing in larger quantity even than in lean beef. Wild-fowl contain still less fat. The flesh of the white-fleshed birds is more tender, more delicate in flavour, and more easily digested than the dark-coloured flesh, for example, of ducks and geese. The latter is, however, richer and more stimulating. Game-birds are desired for their special flavour, which, by stimulating the appetite, counterbalances the disadvantage of the increased firmness and solidity of the flesh. The character of the flesh is, of course, influenced by domestication. If prevented from obtaining exercise, the birds will become fat, and it also appears that, after spaying, the animal fattens more easily, grows to a larger size, and develops a finer flavour. A *capon* is a cock-chicken which has been thus treated, a *poulard* is a spayed hen. The flavour is also markedly different in flesh-eating from that of grain-eating birds. The flesh-eating bird is of a stronger, fuller, and less agreeable flavour, and the feeding of such birds on grain greatly improves them in this respect. The keeping of game, till it is decidedly "high," is for the purpose of making the flesh more tender and easily eaten.

The breast is not always the most tender part of the bird. It is so in the common fowl and the partridge, because these birds walk rather than fly, and the wings and breast muscles are less exercised. But, in the case of the woodcock and snipe, the legs are preferred, because these birds fly most, and the wings consequently are firmer from exercise.

While there seems to be no bird whose flesh is injurious, if eaten, it yet appears that some birds may become poisonous by eating certain foods. The pheasant of North America is said to be poisonous during the winter and spring, if fed on the buds of *Calmia latifolia*, and American partridges have been found to possess poisonous properties (Pavy).

The flesh of hare and rabbit resembles that of fowl rather than that of butchers' meat. It also is characterized by the absence of fat. The flesh of the hare is particularly rich and nourishing, that of rabbit having a less defined flavour; but it is more easily digested, and, just because of its greater delicacy, is more suited for an invalid or convalescent. Hare-flesh is highly nutritious, but is rather for the healthy and vigorous than for the sick.

Venison, the flesh of the deer, resembles game rather than butchers' meat. It possesses little fat, but is rich in extractives, and therefore savoury and stimulating. It is, moreover, readily digestible. The flesh of park-deer resembles that of the domestic sheep because of restricted exercise.

Squirrels are eaten in some of the western parts of America, and by the natives of Australia, and form a favourite dish in Norway and Sweden. The flesh is said to be tender, and to resemble that of the barn-door fowl. The flesh of the opossum is compared to that of the rabbit or hare.

Edible birds' nests are esteemed great delicacies in China. The edible portion of the nest is really formed of dried saliva, and is constructed by the bird, the salangan, a kind of swift, as a support on which its nest is afterwards raised of grass, leaves, and sea-weed. The birds build in caves near the sea or inland, and it is by means of the brackets which the animal makes, that its nest is supported. It is said to require fifty such brackets to make up a pound in weight, and the best of them sell for £5 to £6 the pound. They are obtained chiefly in the islands of the Southern Archipelago.

EGGS.

Percentage Composition of Hen's Egg (Church).

	White.	Yolk.	White and Yolk Mixed.
Water	84·8	51·5	71·7
Nitrogenous	12·0	15·0	14·0
Fat	—	30·0	11·0
Extractives and membranes	2·0	2·1	2·0
Saline	1·2	1·4	1·3

The eggs of a great variety of birds are used as food, and there is no bird's egg which may not be so employed. The eggs of different birds differ much not only in size, &c., but also in flavour. The flavour is mainly determined by the feeding of the bird.

Within the shell the whole egg is inclosed in a delicate double envelope or membrane. Throughout the white of the egg run delicate strands of membrane dividing off compartments in which the semi-liquid white is inclosed. Within the white, inclosed also in a delicate membrane, is the yellow yolk attached to the membranes of the white by two fine cords or chalazæ, one towards each end of the egg, which suspend the yolk and permit it to move readily within the white. It is on the yolk and from a part of it that the young bird is developed. The part is indicated in the fresh egg by a small white area, called the cicatricula, about the sixth of an inch in diameter, which is always uppermost in whatever position the egg is placed. The rotation of the yolk on its chalazæ achieves this. While only a part of the yolk developes into the young bird, the remainder and the whole of the white serves to nourish it till it is ready to break out of the shell. So that within the egg itself is contained all the material necessary for the development of the tissues and growth of the chicken during a considerable period of its existence.

The shell is usually about the $\frac{1}{10}$th of the total weight of the egg, the yolk weighs $\frac{3}{10}$ths, and the white $\frac{6}{10}$ths.

The shell consists of 3 per cent organic matter, and 97 per cent inorganic salts, of which 91 per cent is carbonate of lime, and the remaining 6 per cent is phosphate of lime. It is porous, and thus permits exchanges to go on between the air outside and the contents of the shell. It is because of the entrance, through the shell, of putrefactive germs in the air that decomposition is set up, and the egg becomes bad. This may be prevented by rubbing newly-laid eggs over with fat or butter, which enters the pores and seals the egg, as it were, against the entrance of air. Eggs have been kept fresh for two years, and may easily be kept, it is said, by covering them with a solution of one-third bees'-wax and two-thirds olive-oil. They may be kept for a considerable time also by packing them, small end downwards, in clean dry salt. They may be preserved also in strong solution of salt or in lime-water. Bad eggs swim even in pure water because of their loss of weight owing to decomposition, and the quantity of gas the decay has produced. Good eggs should sink in a solution composed of 1 ounce of salt in 10 ounces ($\frac{1}{2}$ pint) water, and in the same solution indifferent eggs float. The white and yolk of eggs differ very much in their composition, as the tables show. The white is almost entirely a weak solution of albumin in water, for the nitrogenous constituent is pure albumin (see

p. 536), and the water exists to the extent of nearly 85 per cent. So that of the white of egg only $\frac{1}{5}$th part consists of really nourishing material, namely, the albumin. Though in solution in cold water, it becomes coagulated into a white clot when heat is applied, and the albumin in this coagulated condition will no longer dissolve in water. When the composition of the yolk is examined, a marked difference is observed. There is 33 per cent less water, and 30 per cent fat, besides 3 per cent more albuminous or nitrogenous material. The fat may be extracted as a bright yellow oil by means of alcohol or ether. The yolk is much richer then, and more nourishing than the white. Yet the white forms $\frac{6}{10}$ths of the whole egg, so that when the mixed white and yolk are taken, the rich yolk is diluted, as it were, by the weak white, as will be seen on referring to the table. It is sufficiently plain from these tables that eggs are not the concentrated food most people imagine. As a matter of fact an egg scarcely contains more nourishing material than a piece of beef of equal weight. This is proved in more detail on p. 555. A man, restricting himself to eggs alone, could not obtain sufficient waste-repairing and energy-yielding material out of less than eighteen eggs per day.

The inorganic salts of the egg are those of phosphorus, iron, lime, soda, potash, and magnesia.

The weight of the hen's egg is from 1½ to 2 ounces; a duck's egg weighs 2 to 3 ounces, a turkey's 3 to 4 ounces, and that of a goose 4 to 6 ounces. A duck's egg contains a fourth more nourishing material than a hen's egg.

FISH AND SHELL-FISH.

Percentage Composition of White Fish.

	Whiting.	Cod.	Haddock.	Sole.	Skate.
Water........	83·0	77·5	78·0	86·1	73·79
Nitrogenous	15·1	18·5	18·1	12·0	24·03
Fat............	0·8	3·0	2·9	0·7	0·47
Saline.........	1·1	1·0	1·0	1·2	1·71

Percentage Composition of Fat Fish.

	Herring.	Mackerel.	Eel.	Salmon.
Water....	80·71	68·27	79·91	74·45
Nitrogenous....	10·11	23·42	13·57	18·75
Fat...............	7·11	6·76	5·41	6·22
Saline	2·07	1·55	1·11	0·58

In the above tables a rough distinction has been made between two classes of fish, depending on their chemical composition. To the class of lean fish, that is, with comparatively little fat in their composition, belong the fish with more or less white flesh. The commoner examples of this class are given in the table, and to the same class, with a chemical composition of which that of the haddock may be taken as an average, belong turbot, brill, plaice, whitebait, smelt, flounder, hake, ling, gudgeon, and pike. The class to which herring, salmon, &c., belong is characterized by a considerable increase in the quantity of fat, and has usually flesh more or less coloured. The sprat, pilchard, and lamprey belong to the same class. According to the table the herring is richest in fat; but the eel is usually represented as one of the fattest of fish, Letheby's analysis crediting it with nearly 14 per cent of fat, and Payen stating the percentage of fat in the eel, when the non-edible parts have been removed, as nearly 24. It may be remarked here that there are considerable variations in the analyses of different food-stuffs, as given by different authorities, depending upon the state of the particular samples from which the analyses were made. Thus in fish the composition varies with the season, the animal being at its highest state of perfection previous to spawning, when it is fatter, and the flesh has a richer flavour. After spawning the animal is much leaner and the flesh is more watery. It is estimated that during the spawning period as much as 17 per cent of the total fat present in the body may disappear.

In the case of the salmon, herring, mackerel, eel, &c., the fat exists among the muscular substance, and there is also a layer of fat beneath the skin, specially beneath the skin of the belly, whereas, in the cod, skate, &c., the fat is present in greatest amount in the liver, which is, in the season, gorged with oil.

Fish compares favourably with butchers' meat, containing a nearly equal amount of nourishing material, weight for weight, as beef. The extractives, to which butchers' meat owes its richness and fulness of flavour as well as its stimulating properties, are present in less quantity, however. Fish is thus less satisfying and stimulating than beef, and is, on that account, not so extensively used as it ought to be. Because of this, however, its nutritive value is not actually impaired, while these qualities make it of much value to persons of weak digestion and to persons of sedentary habits. Its deficiency, specially the deficiency of white-fish, in fat is easily made up by mixing the diet with fatty substances. Butter sauces, for example, make up for this. Fishing populations have learned this by experience. Thus the people of Cornwall and Devonshire make a fish-pie of fish mixed with thick pieces of fat pork, salted and peppered,and covered by a good crust. They thus obtain all the requisites of a nourishing meal; and the healthy condition of the people shows how satisfactory is the diet. "In no other class than in that of fishers do we see larger families, handsomer women, or more robust and active men" (Dr. Davy). The value of fish from an economic point of view, as compared with butchers' meat, is discussed on p. 555.

The flavour of fish varies with their feeding, the special character of the feeding-ground being the cause of the peculiar excellence of Loch Fyne herring, Dublin Bay haddock, Dogger Bank cod, and Tay salmon. The whiting is the most delicate and tender, and near it is the haddock; the sole, flounder, turbot, cod, hake, and ling follow. The white-fish are the most digestible; and diminished digestibility accompanies increased firmness of flesh. This is seen in cod-fish, which in season is firm, and becomes opaque on boiling, showing curdy material between the flakes. But this very firmness, desirable as indicating seasonableness, is a disadvantage from the point of view of digestion. The firmness of the cod is increased by crimping, which consists in making cross-cuts into the flesh immediately after the fish is killed, and then plunging it into cold water. This is supposed to improve the flavour. The flavour of some fish, such as trout and salmon, is best when they are cooked and eaten speedily after being killed; but others, such as turbot, improve with keeping. The fat fishes are the least digestible of all.

Roe and milt are parts of the reproductive organs, the former, which is the hard roe, belonging to the female, and the latter, the soft roe, to the male. Caviare is the preserved hard roe of the sturgeon.

Many substances of great commercial value are made from various parts of fish. Thus isinglass is derived from the swimming-bladder, specially of the sturgeon. Glue is made from refuse of fish; and so on. The Normal Company, of Aberdeen, has shown that every part of the fish can be utilized, and that the parts of the fish regularly discarded as useless, when properly made use of, represent an enormous money value.

Fish sometimes possess poisonous properties, possibly because of some kind of feeding. Such poisonous fish are met with in the tropics. There are some people injuriously affected by fish at any time, even as others cannot eat mutton or eggs without great disturbance.

There does not seem any scientific ground for the popular notion that fish is a specially useful food for brain workers. It was thought that fish were rich in phosphorus, which enters into the composition of brain tissue, and were, therefore, specially useful. This idea arose from the glow given out by fish in the dark. But such phosphorescence is probably due to a minute organism, and is a thing apart from the chemical composition of the fish.

Percentage Composition of Shell-Fish.

	Lobster.	Oysters.	Mussels.
Water,	76·62	80·38	75·74
Nitrogenous,	19·17	14·01	11·72
Non-nitrogenous and loss,	1·22	1·40	7·39
Fat,	1·17	1·52	2·42
Saline,	1·82	2·69	2·73

The above may be taken as fairly representative of the shell-fish class. They contain a fair quantity of nourishing material. In the case of lobster, crab, crayfish, &c., there are serious objections to their use. They are among the most indigestible kinds of animal food. They are coarse feeders, and this may account for the disturbing effects they so readily produce, apart altogether from any difficulty of digestion. Under any circumstances, however, they excite even serious irritation of stomach and bowels in some persons, producing cramp, colic, purging, and violent symptoms of irritant poisoning; while in others the partaking of even a small amount of shell-fish (and specially mussels) to supper would induce a skin eruption like nettle-rash. Oysters are not so open to this objection; indeed they are frequently found pleasant and appetizing by persons of weak digestion and convalescents. The flesh of the claws of lobsters and crabs is more delicate and digestible than the soft internal parts, which are mainly liver. The mass of little round black bodies, found beneath the tail of the female lobster, is the spawn, and is used for sauce. The beard of the oyster is formed of the gills, and is frequently removed; the large hard portion of the interior, which is a muscular part, ought also to be rejected, as it is the least digestible part. The addition of vinegar, spices, &c., to shell-fish is, as a rule, an aid to their digestion, as these substances act as stimulants to the stomach and promote the flow of the digestive juices. Oysters are more easily digested when raw than when cooked. They are in season only when there is an "r" in the name of the month.

TURTLE.

Both the fresh-water and marine turtle are consumed as food. The former abounds in certain districts of the Continent, and is used by the inhabitants. The *terrapin*, a fresh-water turtle, is imported into this country from America. Land tortoises are also found wholesome and agreeable food by the natives in India and Africa and by the North American Indians.

The edible or green turtle (*Chelonia mydas*) is the one chiefly used in this country. It is from 6 to 7 feet long, and sometimes weighs 700 pounds. They are imported alive; and the flesh cut up into pieces and sun-dried is also imported in large quantity from the West Indian islands. The flesh is sometimes used as steak, but is principally employed for soup. For this purpose the shields covering back and belly are removed from the animal, scalded to allow of the removal of the scales, and boiled. The soft, glutinous parts are then removed from the hard bony portion and cut up into small oblong pieces. It is these pieces that are prized, and are erroneously called green fat. The liquor is used as stock for soup. The shield from the back is called callipash (the carapace of naturalists) and that from the belly callipee—names well known to cooks, epicures, and aldermen. "The callipee, or underpart of the breast or belly, baked, is reckoned the best piece." It is white, like veal or chicken, after being boiled. The meat from the callipash is dark-coloured, and is sometimes called black or green meat. The fat of the turtle is greenish-yellow in colour, and it also is used for soup. It is said to colour the urine and sweat of those who eat of it. Turtle is said to be highly nutritious, and when plainly cooked easy of digestion—tender, delicate food when young, but more tough and gristly as it grows old. "The juices are generally reckoned great restoratives."

The eggs of the turtle are also used as food. They are deposited in great numbers in the sand of the bays and lagoons, to which the turtle resorts for that purpose several times a-year. They are hatched lying in the warm sand, and the difficulty is to procure them in a perfectly fresh state.

The flesh of the turtle is about 75 per cent water, and of the remaining 25 per cent about one-half is fat, the rest being flesh.

Mock-turtle soup is made with pieces of the gelatinous portions of the scalp of the calf's head, which resemble to some extent the glutinous pieces of turtle.

MILK.

Average Percentage Composition of Human Milk and Milk of Different Animals.

	Human	Cow.	Ass.	Goat.	Mare.	Sheep.
Water, ...	88·0	86·87	91·17	87·54	88·80	82·27
Nitrogenous, .	2·97	4·65	1·79	3·62	2·61	7·10
Fat (Butter), .	2·90	3·50	1·02	4·20	2·50	5·30
Sugar, ...	5·97	4·28	5·60	4·08	5·59	4·33
Saline, ...	0·16	0·70	0·42	0·56	0·50	1·00

Milk is an emulsion. It consists, when seen under the microscope, of a multitude of exceedingly fine globules of oil, each globule being surrounded by an albuminous film, which keeps the globules from running together, the globules floating in an opaque fluid. The fluid contains albuminous bodies, milk-sugar, and salts, in solution. When perfectly fresh it is slightly alkaline in reaction, but it soon becomes somewhat acid.

When milk is allowed to stand the oil-globules, being light, rise to the surface and form the layer of cream, so that the cream is mainly the fatty portion of the milk, the globules in it being still separated from one another by the albuminous envelopes. When milk is churned, the albuminous envelopes are ruptured, and the released globules of oil run together, forming little masses of fat. These masses are collected, as much of the liquid squeezed out as possible, and thus the butter is obtained. If a small quantity of acid, say common vinegar, be added to milk and the milk be slightly warmed, it separates into curd and whey. The same thing occurs if the milk is allowed to stand till it becomes sour. The souring is due to the formation in the milk of an acid—lactic acid. The lactic acid is produced by a species of fermentation from the sugar present in solution in the milk. The agent in exciting this fermentation is a minute organism (see p. 389) deposited in the milk from the air. If milk be heated, and corked in a bottle when hot, it will not turn sour, because the heating has destroyed the organism; and no lactic acid being produced, curdling will not occur. But if the cork be removed and the air have access to the milk again, fresh organisms are deposited and curdling will soon take place. The explanation of curdling is this: the chief nitrogenous or albuminous body in milk is called casein. Casein belongs to the same type of substances as white of egg. We all know that white of egg will dissolve in cold water, but as soon as the water is heated to the boiling point it separates or is precipitated as a white curdy mass. Now while casein of milk is akin to white of egg, unlike it, it does not precipitate on boiling, so long as the solution, in which it is present, is not acid but alkaline. As soon as the solution becomes acid, either by the addition of a little vinegar, or by the process of souring, the casein tends to become precipitated as curd, and will be all the more quickly precipitated if the solution is heated. So long as milk is kept alkaline, then, it will not curdle, because casein is soluble in an alkaline solution, and is therefore called alkali albuminate. The addition, therefore, to milk of a little common baking-soda (carbonate of soda) will prevent curdling taking place. Milk is also separated into curd and whey by mixing it with rennet. Rennet is prepared from the stomach of the calf, and contains a special ferment, which causes the precipitation of the casein. In the process of the digestion of milk in the stomach curdling is the first step, being caused by the acidity of the gastric juice, as well as by the presence in the juice of a curdling ferment. If a person vomits some time after a drink of milk, the milk is returned in a curdled condition, because the process of digestion has begun.

The curd of milk thus consists of an albuminous body casein, and entangled in the curd is the most of the milk-fat. The whey also contains some of the fat globules, and is, therefore, somewhat opaque. It contains also a small quantity of albumin of exactly the same character as white of egg, and it contains in solution the sugar, salts, &c., which can be readily separated out. If the whey be gradually evaporated the milk-sugar will crystallize out.

Milk, then, is really a very complex substance, and it contains a proportion of all the different kinds of material needed as food—nitrogenous, fatty, sugary, saline.

We must now look at its composition a little more in detail. It will be observed from the table that the composition of milk varies very much in different animals, that of the ass containing a total of only 8·83 parts of solid material in 100, while that of the sheep contains double the amount of nourishing material, namely 17·73 parts in the 100; and while
human milk contains 12 parts of solids in 100,
cow's milk „ 13·13 „ „

Solids in One Pint of Milk.

Nitrogenous, ...	369 grains.
Butter, ...	351 „
Sugar, ...	468 „
Saline, ...	72 „
Total Solids, ...	1260 grains.
Or fully	2·8 ounces.
Water, ...	17·9 „

Of one pint of cow's milk (20 ounces) 17½ ounces in round numbers are water, and 2½ ounces solid nutriment. If a grown person, therefore, were to live on milk entirely, a very large quantity would be necessary—between 9 and 10 pints daily at least. This would be an expensive diet. It is one, moreover, not suited as an exclusive diet for an adult, while eminently suited for a young growing person (see p. 542).

The nitrogenous ingredients in milk are principally the two already named—egg-albumin and alkali albuminate or casein, the casein being in largest proportion, forming nearly 4 of the 4·65 per cent.

Milk-fat or butter or cream is that which gives the quality and richness to the milk. It is by the amount of cream present that the quality of the milk is commonly estimated. There is a simple instrument, called a creamometer, which might readily be employed in households for determining the richness of milk. It consists of a test-tube (fig. 192) 11 inches long and ½ inch in diameter, which is divided into 100 degrees by a scale. The milk to be tested is well shaken to mix the cream uniformly and then the test-tube is filled with it up to the mark 0. The tube is allowed to stand upright for 24 hours, and the depth of the layer of cream on the top read off at the end of that time. Good sweet milk should give a layer of cream not less than 11½ degrees. This is, however, not a very reliable gauge, because the amount of cream which rises depends on many conditions. More cream will rise if the temperature is low, if the vessel which contains the milk is wide, and if the vessel is kept perfectly free from agitation. Another method of determining the quality of milk, which gives results varying according to whether the cream has been removed or not, is the method by taking the specific gravity of the milk. A hydrometer is used, such as is shown in fig. 193, which should sink in pure water to the level of the mark 0, which stands for 1000. In pure sweet milk it should rise to a level between 29 and 33 (1029 and 1033). That is to say, the specific

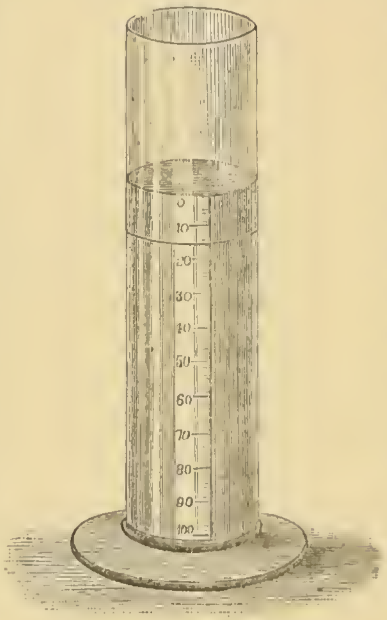

Fig. 192.—Creamometer.

gravity of pure milk varies between 1029 and 1033. Now such milk contains say about 12 per cent of cream, and if from a sample of pure milk any quantity of cream has been skimmed, the reading from the hydrometer will be considerably different. Cream, consisting as it does mainly of fat, is lighter than water. If, therefore, a large quantity of cream be present in a sample of milk, its specific gravity will be lowered; and if the cream be skimmed off, the specific gravity of the milk will be raised. Thus pure milk with all its cream, which gives a specific gravity of between 1029 and 1033, will, if the cream be removed, give a specific gravity of between 1033 and 1037. If we take these two levels as the standards of pure sweet milk and pure skimmed milk, it is plain that the addition of water to either will cause a lowering of the specific gravity. A table has been constructed, showing the fall for varying quantities of water, and thus, by using the hydrometer, with this table a rough estimate of adulteration of the milk with water might be made.

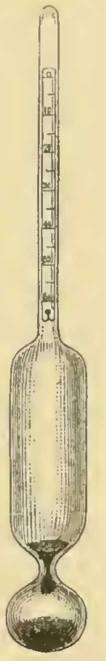

Fig. 193. Hydrometer.

Table Showing Specific Gravity of Milk before and after Removal of Cream with Different Quantities of Added Water.

Specific Gravity before Removal of Cream.	Specific Gravity after Removal of Cream.	
1029 to 1033	1034 to 1037	Indicates Pure Milk.
1026 ,, 1029	1029 ,, 1034	= 10 p.c. added water.
1023 ,, 1026	1026 ,, 1029	,, 20 ,, ,,
1020 ,, 1023	1023 ,, 1026	,, 30 ,, ,,
1017 ,, 1020	1020 ,, 1023	,, 40 ,, ,,
1014 ,, 1017	1016 ,, 1020	,, 50 ,, ,,

Hydrometers are graduated for use with milk only, and are then termed **lactometers**. Different makers graduate the lactometers in different ways. Thus one is made graduated from 100, low down on the stem, to 0 at the top of the stem. In pure water it would sink to 0, in pure milk the stem would stand out above the milk to the level 100. If it sank so that the stem stood out to the level 90 only, that would indicate that, in 100 parts, only 90 were pure milk and 10 were added water, and so on. The graduation might begin low down at 0, at which level the lactometer should stand in pure milk, and from that point up the stem the marks would indicate percentages of added water. Thus if the instrument sank to 5, that would mean 5 per cent added water. If this method of testing the quality of milk were used, and it would be of easy domestic application, it should be employed in conjunction with the creamometer, else mistakes would arise. Take an example: a fraudulent milkman might remove a portion of cream from his milk, and in consequence the specific gravity would rise, say to 1034, indicating skimmed milk. He might then bring the specific gravity back to what it ought to be for pure milk by adding water. Of course the milk would look thin, but still the specific-gravity test alone would not indicate anything wrong. If, however, the creamometer test were applied, and a marked deficiency in cream shown, the explanation would be evident. For purposes of such testing the milk should be well mixed before the sample is poured out.

The sugar of milk or lactose contains the same proportions of carbon, hydrogen and oxygen as cane-sugar, but is of feebler sweetening power, and does not readily undergo the alcoholic fermentation, but is prone to the lactic acid fermentation, which, as already stated, is the cause of the souring of milk.

The **saline constituents** consist of salts of soda, potash, lime, magnesia; oxide of iron, and compounds of phosphorus and chlorine are also present. Milk also contains fluorine, which is an ingredient in teeth. Of the total mineral constituents phosphoric acid forms no less than about 28·5 per cent.

The composition of milk varies much with the feeding of the animal. If an abundance of suitable food be allowed to the cow, and exercise be denied, the yield is increased, and the quantity of solids in the milk is also increased. Stall-fed cattle yield more butter, because less fat is consumed in the body for yielding energy for exercise and the maintenance of temperature.

The flavour of the milk is also influenced by the feeding, the finest being yielded by feeding on fresh country pasture. Turnips and fragrant grasses impart an odour to the milk. Milk also may be coloured by food eaten, and may acquire poisonous properties, without the animal being affected, by the cow, goat, &c., feeding on certain plants. This is noticed in Malta and some districts of North America.

The milk of a cow varies also at different times of the day, and the milk obtained at one milking is not all of the same richness. The afternoon milk is said to be twice as rich in butter as the morning milk. If, as a cow is being milked, the milk is divided into several portions as it comes from the udder, the milk that came first is found to vary very much from that yielded by the stripping of the udder. The chief difference is in the quantity of butter, the first milk, or as it is called the "fore" milk, being very poor in fat, while the last milk, or the "strippings," is rich in fat. Any one, therefore, who wishes to see a fair sample of milk yielded by a particular cow should see the cow completely milked. The whole milk should be collected in one vessel, and a sample of that taken. The cause of the difference is found in the lightness of the cream, which makes it rise to the highest part of the gland.

The average quantity of milk yielded by the cow varies with the breed. The Yorkshire shorthorn, the favourite of London dairymen, is estimated to yield on a yearly average nearly a gallon and three quarters per day (strictly 1·7 gallons per day). A good average yield is said to be 15 pints per day, but, as already stated, it varies with the feeding, exercise, &c., not to speak of the condition of the animal. The udder of the cow is estimated to be able to contain about 5 pints of milk at one time.

As an agent in the communication of disease milk must not be ignored. It is perfectly certain that milk is continually the agent in spreading typhoid fever. Probably, indeed with certainty, this arises from water tainted with excretions from a patient suffering from typhoid fever, gaining access to the milk. A very common story is that some farm hand takes ill with what is called a feverish cold or gastric fever, and is ill for some weeks. The discharges are, without any precaution, cast on the dung-heap, and fluid from it finds its way into the burn or well, from which the household obtains water. This water is used to wash the milk-vessels, not to say to add to the milk, and is then conveyed to a neighbouring town or village. Germs from the patient have thus gained entrance to the milk, where they multiply, and if the milk be used unboiled, it may convey the disease to whomsoever partakes of it. In recent years it has also become almost certain that the milk of a diseased cow may occasion disease in persons partaking of it. An outbreak of scarlet fever in Hendon, in England, and another in Glasgow, were almost conclusively traced to the use of milk, yielded by cows suffering from a febrile disease, and it has become highly probable that the scarlet fever of the human subject has its counterpart in the cow, and that it may pass from the cow to the human being by the medium of the milk. Another disease that numerous investigations have shown to be probably communicable from the cow to man by the medium of milk is tubercle, the chief if not only cause of consumption of the lungs (see p. 277). It is becoming more and more certain that specifically tainted milk is constantly sold in large towns, and the question for each one to ask is, how protection against it is to be secured. It has been shown that milk containing infection may evidence to chemical analysis no change whatever, and there is really no test of quality, taste, flavour, &c., which is of any value on this question. If the milk consumer wishes any guarantee of protection, the only one of real use he can himself supply *by bringing to the boiling point, and keeping boiling for one or two minutes, every drop of milk that enters his house*, the vessel into which it is poured from the pot being previously scalded. That is to say, to be thorough, the milk is not to be poured from the pot back into the vessel, which held it at first, unless every particle of unboiled milk has been removed from the vessel by boiling water. **Human milk** varies with feeding, &c., much as cow's milk does, and is altered by disease. Medicines administered to a nursing mother may affect the child, and, therefore, caution in giving such drugs, as mercury, opium, laudanum, &c., to a nurse is necessary. Human milk, as shown by the table, contains less nitrogenous and fatty material than cow's milk and more water and sugar. To bring cow's milk more nearly to the composition of human milk, the addition of water and sugar is necessary. The following quantities are advised:—

20 ounces (1 imperial pint) cow's milk,
10 ounces (½ ,, ,,) boiling water,
1½ ounces sugar (preferably milk-sugar),
Mix.

It is said that cow's milk coagulates in larger curds than human milk, and that this accounts for the greater difficulty infants experience in digesting cow's milk. This is remedied by boiling, which causes curdling to occur in more flaky masses.

Percentage Composition of Cream, Skim-milk, Butter-milk.

	Cream.	Skim-milk	Butter-milk.	Devonshire Clotted Cream.
Water, ...	55	89	90·62	28·68
Nitrogenous, ...	6	4·3	3·78	4·05
Butter,...........	36·3	0·4	1·25	65·01
Sugar,.......... .	2·5	5·5	3·70	1·77
Saline, ...	0.2	0·8	0·65	0·49

Cream.—The composition of cream varies very considerably, the quantity of fat varying as much as between 12 and 50 per cent, and the water in like proportion. Much depends upon the method employed for the removal of the cream, centrifugal machines performing the process more completely than the old method.

Skim-milk varies in composition for the same reason, but the percentage of sugar is always higher than in uncreamed milk.

Devonshire Cream is of a pasty consistence. It is obtained by keeping the milk in large pans at a moderate heat for a prolonged period, and removing the scum that rises to the surface.

Butter-milk, though it is what is left of the milk after removal of the butter by churning, yet contains a quantity of butter in minute particles. Owing to the souring which has taken place, however, much of the sugar is converted into lactic acid, though it is stated in the table as sugar, and the longer it stands the more complete does this conversion become. It is rich in nitrogen, and with other food is a valuable article of diet.

Percentage Composition of Condensed Milk.

	Anglo-Swiss Coy.'s, made in Switzerland.	Made in England.	American (no Cane-sugar added).
Water, ...	24·13	24·99	48·59
Nitrogenous, ...	13·67	10·02	17·81
Butter, ...	8·67	10·88	15·67
Milk-sugar, ...	10·82	11·92	15·40
Saline, ...	2·23	1·96	2·53
Added Cane-sugar	40·48	40·23	———

Condensed Milk.—The above analyses give a fair idea of the average composition of condensed milk. The usual method of preparation is to evaporate the milk in vacuum-pan and then to heat to the boiling point, cane-sugar being added. The milk is then preserved in tightly-soldered tins, so that air has no access. In other cases the milk is concentrated, no cane-sugar being added, so that the simple milk deprived of most of its water is obtained. Of the former kind two analyses are given, showing fully 40 per cent added cane-sugar. This makes such milk exceedingly sweet and unpleasant to many people, though the presence of the sugar enables the milk to keep for a considerable time after the tin has been opened. Of the unsweetened kind one analysis is given. It keeps for a much shorter time after the tin has been opened. On the other hand, it will be observed that this latter kind contains, weight for weight, much more actual milk solids than the former. Thus the unsweetened contains, in 100 parts, 51·41 parts of the actual solids of milk, curd, butter, milk-sugar, and salts, while the sweetened variety contains, in 100 parts, only 35·39 of actual milk solids, though the total solids in 100 parts are brought up to 75·87 by the added cane-sugar. To put it in another way, by the lowest estimate good milk contains not less than 9 parts in 100 of solids, not counting butter. If, therefore, the total solids, excluding butter, present in a sample of condensed milk, be divided by 9, the figure obtained will indicate the amount of condensation to which the milk has been subjected, and, therefore, the original quantity of milk represented by the condensed sample. Thus, in the third analysis given above the total solids, excluding butter, are—

Nitrogenous, ...	17·81
Milk-sugar, ...	15·40
Saline, ...	2·53
	35·74

which, divided by 9, gives 3·97,

as nearly as possible 4. That is to say, the milk has been concentrated 4 times, or the 100 parts condensed milk represent 400 parts of the original milk. If one table-spoonful of this condensed milk be made up to four table-spoonfuls with water, one has restored the degree of strength of the original.

Now take the first sample, it contains of solids, not including butter,

Nitrogenous, ...	13·67
Milk-sugar, ...	10·82
Saline, ...	2·23
	26·72

which, divided by 9, gives 2·97, say 3.

This milk has been concentrated only 3 times; 100 parts represent only 300 of the original, and one table-spoonful would stand bringing up to only 3 with water to restore the original strength. Of course it has, in addition, cane-sugar, but when one buys condensed milk it is not cane-sugar one pays for, and when one feeds an infant on condensed milk it is not syrup one wishes to give.

The use of the simple rule given above will enable consumers of condensed milk to measure exactly what they are doing. When they buy the tin of milk, if its composition is not stated on the tin, let them ask for a note of its composition. The dealer who supplies it will also be able to obtain this for them. With the table of composition before them, let them sum up the total of the percentages of "solids not fat," that is, the totals of the nitrogenous or albuminoids, the milk-sugar (not the cane-sugar), and the saline, and divide the total by 9. They will thus know how much to bring the condensed up to with water to get the composition of pure milk, and if it is for an infant it can then be further diluted according to the age of the child.

Percentage Composition of Koumiss.

Water, ...	87·87
Nitrogenous, ...	2·83
Milk-sugar, ...	3·76
Lactic Acid, ...	1·06
Butter, ...	·94
Alcohol, ...	1·59
Carbonic Acid, ...	·88
Saline, ...	1·07

Koumiss is obtained from milk by fermentation. It is specially a drink of the Tartars, and is prepared by them from the milk of the mare. Camel's milk is used for its production by the Arabs. Other kinds of milk may also be employed. Cows' milk sweetened is used in London. The actual composition of the koumiss in each case will depend upon the milk used. The Tartars add 10 parts of fresh warm milk, in which a little sugar is dissolved, to one part of milk already soured by standing. Fermentation proceeds, by which the sugar is converted partly into lactic acid, and alcohol and carbonic acid are produced. Its use is largely extending. It is nutritious, easily digested, and has some slight stimulating property on account of the alcohol contained in it. Fashion has perhaps as much to do with its employment in cases of disease as any actual benefit derived from it. It is specially extolled in the treatment of consumption.

CHEESE.

Percentage Composition of Soft Cheese.

	Camembert.	Neufchatel, fresh.	Roquefort.	Brie.
Water	51·94	37·87	34·5	51·87
Nitrogenous	18·90	17·43	26·5	18·30
Fat	21·05	41·30	30·0	24·83
Sugar	3·40	—	4·0	—
Salts	4·71	3·40	5·0	5·0

Percentage Composition of Hard Cheese.

	Cheddar.	Dunlop.	Gloucester, single.	Gloucester, double.	Stilton, fresh.	Gorgonzola.	Gruyère.	Parmesan.	Skim-milk.	American.
Water	27·83	38·46	21·41	34·3	32·18	43·56	34·68	27·56	48·02	30·13
Nitrogenous	44·47	25·87	49·12	29·2	24·31	24·17	31·41	44·08	32·65	33·81
Fat	24·04	31·86	25·38	29·6	37·36	27·95	28·93	15·95	8·41	32·88
Sugar	—	—	—	2·0	2·22	—	1·13	6·69	6·80	—
Saline	3·66	3·81	4·09	4·9	3·93	4·32	3·85	5·72	4·12	3·18

Cheese is chiefly the curd of milk, containing also a proportion of fat, entangled in the curd, varying in quantity according to the quantity of fat present in the milk from which the cheese is made, and a small quantity of the saline constituents of the milk. A small quantity of milk-sugar is present, chiefly in soft cheeses, but it undergoes alteration in process of ripening.

Fresh milk is warmed to a temperature of 80° F., and then rennet, made from the calf's stomach, is added to it along with a proportion of colouring matter, usually annatto.[1] It is allowed to stand for an hour, by which time the curd has formed. The curd is then cut up into small pieces and the whey poured off. Some of the whey is heated and poured over the curd to scald it. The curd is then removed, put into a vat, and placed under a press to expel the whey. The curd is thereafter broken up again and mixed with salt, two pounds of salt to the hundredweight of curd. The cheese is then pressed in a mould. It is then bandaged with cloths, removed from the mould, placed aside, and turned daily for five or seven days. It is then removed to the shelf of a room, kept at a temperature of 75°. It is daily turned, greased and polished, and after three or four months is ready for use. Large factories, fitted with all sorts of mechanical contrivances for carrying on the process of cheese-making, now exist, especially in America, and the cheeses they produce are of a more uniform quality. While rennet is usually employed, acid—vinegar—and other agents for curdling, may be made use of, and cheese may be made from sour milk without the addition of any such agent, the natural production of lactic acid causing coagulation.

The richness of the cheese in fat depends upon the milk used. Whole-milk cheese is made from the fresh milk, without skimming; and examples of this kind are Cheddar, Dunlop, and American. When whole-milk is used with the addition of some cream—the whole-milk of the morning and the cream of the previous evening's milking—a richer cheese is produced such as Stilton. Single Gloucester is made from a mixture of the entire milk of the morning and the skimmed milk of the previous evening; double Gloucester is made from entire milk. Neufchatel, Camembert, and Fromage de Brie are cream-cheeses. Roquefort is made from the milk of the ewe, and is kept at a uniformly low temperature during the ripening process, for which purpose the cheeses are kept in subterranean cellars. Skim-milk cheese is poor in fat. Dutch and Parmesan are examples. If the milk has been skimmed twice a very poor cheese is obtained. There is a very hard kind of cheese produced in Suffolk from milk skimmed several times, concerning which it is said that it often requires an axe to cut it, "that pigs grunt at it, dogs bark at it, but neither of them dare bite it."

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[1] Annatto is a dye obtained from the pulp, with embedded seeds, of a small South American tree, *Bixa Orellana*. It is very commonly adulterated with turmeric, red earths, red-lead, copper, and other substances. Its use is not to be commended.

From 9½ to 10 pounds of milk are required to make 1 pound of whole-milk cheese—that is to say, about a gallon of milk yields 1 lb. cheese. One cow will yield from 3½ to 4 cwt. of cheese per annum.

In the ripening of cheese various chemical changes occur, which make the cheese more readily digested than when it is fresh. Both the curd and the fat undergo changes of a fermentive kind. By the same process the peculiar flavour of the cheese is developed. In the process of ripening a mould appears, common vegetable fungoid growths developed from spores that have gained entrance to the cheese in course of manufacture. These vegetable moulds grow at the expense of the substance of the cheese, and therefore diminish its absolute nutritive value. On the other hand, they add to its flavour and its digestion, probably to some extent mechanically by the fine veinlets of mould permitting the cheese more readily to crumble down and be attacked in smaller particles by the digestive fluids. The cheese-mite, or *Acarus domesticus,* is produced from the eggs of the insect sown in the curd. Cheese-maggots are the larval stage of a fly, the cheese-fly—*Piophila casei.* These may be destroyed by strong heat or immersing the cheese in whisky.

It will be noticed from the tables of composition that cheese is rich in nitrogenous ingredient and fat, whole-milk cheese containing these to the extent of over two-thirds. While this is so, there is a difficulty in making use of these nourishing ingredients from the solidity of the mass, and thus cheese is used rather as a mere adjunct to food than for its nutritive value. Cream-cheeses are usually more easily digested, because the large proportion of fat makes them crumbly and more easily broken down. When cheese, however, is mixed with other food-stuffs, as with corn-flower, bread, &c., when grated to form cheese-pudding, these ingredients separate up the cheese particles; and then a quantity may easily be taken—sufficient to be of considerable nutritive value. Such additions also make up what is deficient, indeed practically wanting in cheese, the starchy or sugary element. It may further be noticed that the saline constituents of cheese are rich in phosphates, of value in bone formation. In a sample of double Gloucester of a total of 4·9 per cent salines, phosphates contributed 3·1.

Various Animal Foods Compared.

It will now be of interest and value to compare the relative richness in nutriment of the various animal foods we have considered. For that purpose I shall place alongside of one another the composition of the chief kinds of such food from the tables already given:—

	Lean Beef.	Bacon.	Fowl.	Egg. *	Cod.	Milk.	Cheese (Cheddar).
Water	72	13·9	73·15	71·7	77·5	86·87	27·83
Nitrogenous	19·3	9·0	22·65	14·0	18·5	4·65	44·47
Fat	3·6	74·1	3·11	11·0	3·0	3·50	24·04
Sugar	—	—	—	—	—	4·28	—
Saline.........	5·1	3·0	1·09	1·3	1·0	0·70	3·66

* 2 per cent of extractives and membranes omitted.

If we exclude water and salines then from the above tables, we find that 100 parts of each food-stuff contain of nourishing materials the following amounts:—

Beef, ...	22·9
Bacon, ...	83·1
Fowl, ...	25·76
Egg, ...	25·0
Cod, ...	21·5
Milk, ...	12·43
Cheese, ...	68·51

This shows that beef, bacon, fowl, egg, and cod come very near to one another in the proportion of nourishing material they contain. Cheese stands high in the list, but it is really in a different class from the others, because it cannot be eaten in any quantity, and is really a food adjunct, and cannot take the place of a chief article of diet. Allowing, then, for variations in composition, we may say that, weight for weight, beef, bacon, fowl, egg, and cod are comparatively nearly of equal nutritive value, considering the total nutriment each contains. Considering the details of the composition, we see how alike beef, fowl, and cod are, and how one could readily take the place of the other in a diet, without any deficiency in a particular ingredient arising from the change. It is specially interesting to note how completely fish may take the place of beef; and, when we remember the marked difference in price between the two, this is a point worthy of being brought markedly into prominence. It is an irresistible plea for the more extended use of fish in the diet of the people. Bacon heads the list; but the small proportion of nitrogenous material and the excess of fat exclude it from entering into serious competition with the other three, though it is nevertheless a highly valuable food-stuff. It is evident also that egg occupies a similar platform to beef, fowl, and fish, and at any rate does not possess any marked pre-eminence. It has no right to be considered, as it so commonly is, a concentrated food-stuff.

II. Non-Nitrogenous Animal Foods.

BUTTER AND BUTTER SUBSTITUTES, LARD AND DRIPPING.

Percentage Composition of Butter and Oleo-margarin.

	Butter.	Oleo-Margarin.
Water	9·40	10·50
Nitrogenous (Curd)	1·40	—
Fat	86·50	87·00
Milk-sugar	·80	0·70
Saline	1·90	1·8

Butter, though consisting mainly of milk-fat, contains a small proportion of the other ingredients of milk. Butter may be made directly from the sweet milk, but usually is made from cream. Rather more butter is obtained from the whole milk, but the process is more laborious, because of the large bulk of fluid. It takes about 23 pints of milk to yield 1 lb. of butter. A good cow will yield 8 to 12 lb. of butter a week during the season; and well-selected cows will yield on an average 2 to $2\frac{1}{4}$ cwt. of butter per year. The milk is placed in shallow pans and kept at a temperature of about 60° F., at which temperature the cream rises best. Once or twice in twenty-four hours the cream is removed, and placed in a crock till sufficient has been collected. Sometimes annatto is added to it to give a colour, or grated carrots are steeped in it and strained out next morning for a like purpose. In large establishments for the manufacture of butter, the cream is now separated by centrifugal machines. Owing to the keeping the cream becomes slightly sour, because of the change of some of the milk-sugar into lactic acid. This facilitates the separation of the butter, though butter made from sweet cream has a pleasanter taste, and is said to keep much longer. The cream is then placed in a churn, of which there are many forms. Whatever their form, the purpose is the same, namely, by mechanical agitation of the milk globules to break the fine film of albumin which surrounds them, and thus to permit the escape of the oil. The fat thus released runs together, and lumps of butter are produced. The cream is put into the churn at a temperature of about 60° F., at which it is kept. The churning process occupies from thirty to forty-five minutes. The butter is then collected, washed in cold spring-water, to rid it as much as possible of the other elements of milk, and is then kneaded to express the water. It is thereafter mixed with salt as a preservative. In fresh butter there is always added salt to the extent of $\frac{1}{2}$ to 2 per cent. Salt butter contains from 3 to 6 pounds of salt to every 112 pounds of butter, and if it is to be kept for an unusually long time a little sugar is added, not exceeding 8 ounces to every 112 pounds. During the whole process great care requires to be taken to ensure the cleanness of the vessels, churns, &c. used, and of the atmosphere in which the butter is kept. For butter very readily acquires a change of flavour from odorous or smelling substances in its neighbourhood, as well as from any highly-flavoured food eaten by the cow. While the above table gives a fair average composition, very varying results are obtained from different samples. The quantity of curd, milk-sugar, and water will depend upon the care and thoroughness with which the butter has been washed and pressed. An increase in the quantity of curd present diminishes the keeping quality of the butter, from the tendency of the curd to undergo decomposition. The milk-sugar and curd are present in too small quantity to impart any nutritive quality of any consequence apart from the fat.

There is a simple method of making a rough estimate of the quantity of the three chief constituents, which will aid in determining the quality of any particular sample of butter. Place some butter in a test-tube, and melt it by immersing the tube in warm water. As soon as the butter becomes liquid, it will separate into its chief constituents, a layer of water at the bottom, a layer of oil on the top, and between the two a ring of curd. The water should form little more than an eighth of the total liquid in the tube, the oil should form the remainder, the ring of curd being of no marked extent. Any adulteration with water would be quickly detected by such a simple method as this, and any excess of salt would also be noticed. Butter fat is a very complex substance. It is a mixture of various fats, the chief being olein, stearin and palmitin, and butyrin; while, in small quantity, there also exist other fats, called caproin, caprylin, and rutin. Each of these fats is a chemical compound of a fatty acid and glycerin. Thus oleic, stearic and palmitic, and butyric acids are the acids which, in combination with glycerin, yield the fats olein, &c. The oleic, stearic, and palmitic acids do not dissolve in water, but the others do dissolve. Now sometimes a bad flavour is formed in butter by the decomposition of the butyrin and caproin into their respective fatty acids. These being soluble, the bad flavour may be removed by washing the butter.

In 100 parts of butter-fat the proportion of the several fats is as follows:—

Olein	42·21
Stearin	50·00
Palmitin	
Butyrin	7·69
Caproin	0·10
Caprylin	
Rutin	

Although the last four fats exist in comparatively small quantity, it is they which give to butter its peculiar flavour, distinguishing it at once from other animal and vegetable fats, and it is on the quantity of these last four that analysts mainly depend for distinguishing between pure butter and manufactured substitutes, as will be seen from the analysis given below of the fat of oleo-margarin.

Oleo-margarin, margarin, or **butterine** are various names given to articles manufactured from various animal fats as substitutes for butter. The process is briefly as follows:—Beef fat is principally used. It consists chiefly of stearin, margarin, and olein. It is melted by means of hot water, when the animal fat separates as a yellow oil, water and solid particles sinking to the bottom. A scum of impurities forms on the surface, which is removed, and the oil is run into troughs, where it is kept till much of the stearin crystallizes out. The oleo-margarin is afterwards removed and filtered through cotton, the separated stearin being afterwards used for the manufacture of candles. The oleo-margarin is put into a press and then churned with milk, it being itself quite tasteless, to give it the flavour of butter. It is next coloured, and, after rolling with ice, is packed for use.

As will be seen from the table the composition of oleo-margarin does not differ materially from that of butter. It is indeed a matter of difficulty for experts to distinguish well-made oleo-margarin or butterine from pure butter. Chemists agree in declaring wholesome butter substitutes to be as valuable a food-stuff as pure butter, and to be really not one whit inferior. Its cheapness brings it within the reach of many who find it difficult to purchase the real article. The prejudice against its use is not justified. It is, unfortunately, too often the case that butterine is sold as real butter, and at, or nearly at, the price of the native product. If the people would put prejudice aside, and instead of buying inferior kinds of butter, be not ashamed to buy good quality of butterine or oleo-margarin, they would get an article not easily distinguished from the best butter, at a much more moderate cost. Legislation, instead of hampering the manufacture and sale of these butter substitutes, is now endeavouring to secure that butter substitutes shall not be sold under the name and at the higher price of butter. Chemists distinguish between pure butter and butter substitutes by the proportions of the various fats in each. The fat of oleo-margarin contains:

Olein	30·4
Stearin	46·9
Palmitin	22·3
Butyrin	0·4
Caproin	
Caprylin	

The marked deficiency in the last three fats as compared with their amount in true butter is evident by comparison with the table of composition of butter-fat given above.

Lard is the fat of the pig melted out from the tissue of which it formed a part. This is done by cutting up the fatty tissue into small pieces and placing them in vessels, usually made of iron, heated by steam. As the fat melts, any water and debris fall to the bottom, and other impurities rise to the surface. The pure lard is run off into bladders or kegs. Pure lard should have no smell and almost no taste, and should be quite free from colour. It usually contains nearly 10 per cent of water, though by various methods it may be made to take up a much greater quantity than this. Smith states that lard should contain 8,237 grains of carbon per pound, the hydrogen it contains being reckoned as carbon (see p. 532).

Dripping is fat obtained in the process of roasting flesh. It is almost a pure fat, and differs from lard mainly in the flavour it has derived from the meat. Both lard and dripping are highly valuable as energy-yielding food-stuffs.

THE COMPOSITION OF VEGETABLE FOODS.

I. Nitrogenous Vegetable Foods.

THE CEREALS OR GRAINS.

Average Percentage Composition of Grains.

	Wheat.	Oats.	Rye.	Barley.	Indian Corn or Maize.	Rice.	Millet.	Buckwheat.	Dhurra, Indian Millet.
Water	13·56	12·92	15·25	13·78	13·88	14·41	11·26	13·4	12·2
Nitrogenous	12·42	11·73	11·43	11·16	10·05	6·94	11·29	15·2	8·2
Fat	1·70	6·04	1·71	2·12	4·76	0·51	3·56	3·4	4·2
Starch, Sugar, &c.	67·89	55·43	67·83	65·51	66·78	77·61	67·33	63·6	70·6
Fibre	2·66	10·83	2·01	4·80	2·84	0·08	4·25	2·1	3·1
Saline	1·77	3·05	1·77	2·63	1·69	0·45	2·31	2·3	1·7

With one exception all the substances mentioned in the above table belong to the natural order of the grasses (*Graminaceæ*). The term "cereals" is employed to include them, meaning the fruit of such grasses as are used for food. Buckwheat is not a grass, but belongs to the same natural order as rhubarb and dock (*Polygonaceæ*). It is used pretty much as are the grains, and, therefore, we may consider it here.

The nutritive value of all these substances is clearly evident from the above table. The analyses of the first seven are from a German source (Kœnig), and represent the average of several hundred analyses; the last two are from an English source (Church).

If we leave out the water, the fibre, which is non-digestible, and the saline constituents, then we find that some of these seeds contain as much as 85 parts (rice) of nourishing material in the 100, while only barley and oats fall below 80 per cent. In regard to oats, I do not think the table above does it justice. Its total nutritive material is represented as falling as low as 73 per cent. Nowhere are oats used so largely or grown to such perfection as in Scotland, and the above table is not a fair representative of good Scotch oats. But I preferred to give the analyses as nearly as possible all from the same authority, to make comparisons more fair, and therefore have not substituted another analysis in this case in place of Kœnig's. An analysis of six samples by Fehling gave from 80·93 to 82 per cent of nutritive material. Without doubt the finest qualities of oats contain an excess of nutritive material over that of the finest English wheat.

When the details of the composition are examined some very interesting facts are brought out. They all contain both the tissue-repairing and the energy-yielding kinds of food-stuffs. In all of them the energy-yielding food-stuffs, starch, sugar, and fat specially abound, though the tissue-repairing material (nitrogenous) is in very good proportion. According to the above table the following is the order of richness in nitrogenous or proteid substances:—

Buckwheat.
Wheat.
Oats.
Rye.
Millet.
Barley.
Maize.
Dhurra.
Rice.

The following is the order of richness in fat:—

Oats.
Maize.
Dhurra.
Millet.
Buckwheat.
Barley.
Rye.
Wheat.
Rice.

The following is the order of richness in carbohydrates (starch, sugar, &c.):—

Rice.
Dhurra.
Wheat.
Rye.
Millet.
Maize.
Barley.
Buckwheat.
Oats.

If we take all three nutritive materials, then, of the ordinary grains used as food oats and wheat rank highest, and, considering the finest qualities, oats have the pre-eminence.

Wheat is an annual grass, of which there are several species. That commonly grown in England is *Triticum vulgare*, of which there are two varieties—summer and winter wheat (*Triticum æstivum* and *T. hybernum*). It is cultivated in nearly all temperate climates, but more in the northern than southern hemispheres. It varies much with the soil on which it is reared, and with the dryness or wetness of the season. There is the hard wheat, such as is grown in Odessa, Africa, and Egypt. It is horny and semi-transparent in appearance, is specially rich in nitrogenous or proteid material, and less rich in starch than the average shown in the above table. It is from such kinds that macaroni and vermicelli are prepared. The soft or white wheat is more tender and floury, is more easily ground, contains more starch and less nitrogenous material, and makes a finer flour. There is an intermediate variety grown in France.

Wheat, as supplied to the miller, is deprived of its husk. The seed consists of an outer portion, formed of a series of coverings or membranes, and of an inner part, the substance of the seed itself, divided off into compartments in which are starch grains. The figure (Fig. 194) shows these different parts when a thin slice, taken across a grain of wheat, is examined under a highly magnifying microscope. The various coverings are removed in the process of grinding and dressing for flour and form the bran, while it is from the starchy centre that the fine flour is made. The branny coatings are specially rich in nitrogenous material, though the starchy centre is not by any means devoid of it, the compartments in which the starch grains lie being formed of albuminoid material. It appears that the innermost layer of the seed covering (3 of Fig. 194) is richest in albuminoid material. In this coat there is also present, it appears, a ferment (cerealin) capable, under proper conditions of heat and moisture, of converting the starch of the grain into sugar.

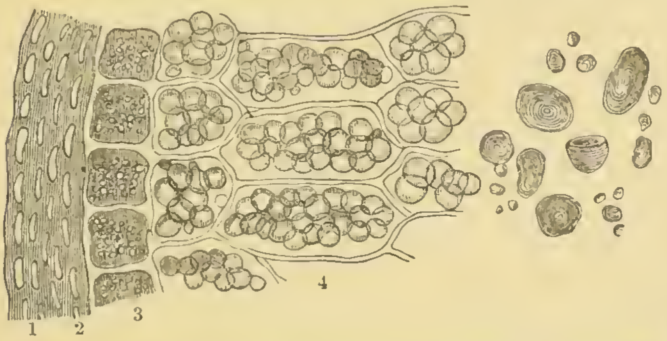

Fig. 194.—Section of Wheat Grain—highly magnified. To the right the granules of wheat starch are shown more highly magnified.

1 indicates the outermost seed-coat, formed of several rows of thick-walled cells, 2 is an inner fine seed-coat, and 3 are called the gluten cells where the cerealin is found. All these yield the bran. 4 points to the compartments filled with starch grains.

Whole wheat is hardly at all used for food; but it once made a popular dish in England, called **frumity or furmenty**, which is still occasionally seen in Yorkshire. It was a common dish in harvest-home celebrations. In its preparation new wheat was steeped in water in a pan, placed in the oven and kept at a temperature of about 120° Fahr. for some eighteen to thirty-six hours. Not only did the grain swell in the process, but by the heat and moisture the ferment was enabled to act upon the softened and ruptured starch grains, converting them into sugar. The grain was then boiled with milk; and sweetening and spice were added. It is said to be a delicious dish, but the presence of the husk and bran made it indigestible.

By the grinding of wheat various products are obtained. The whole grain may be ground as finely as possible, no part being removed. Modern methods of milling now make it possible for very much finer whole meal to be placed in the market than formerly. Some of the objections to whole meal have thus been removed. The branny portions are not easily reduced to a fine condition, and if they are present in the meal in particles of any size, not only are they indigestible, but their roughness and their sharp edges irritate the bowels, and so stimulate them as to cause the food to be hurried along the bowel before the nutritive material can be extracted from it. Indigestible themselves, they thus also prevent the due digestion of other food. The grinding of wheat has now, however, become a very elaborate process, and in mills, constructed and furnished in the most approved fashion, a very large variety of products is obtained from the wheat. The wheat is passed between rollers, in which it is submitted to a cracking and squeezing action, the purpose of which is to enable the kernel to be separated from the other coverings. It is passed through a series of rollers, five, six, or seven, being submitted between each "break" to a series of sifting and winnowing and dressing operations, by which branny particles are separated out, and the flour which the "break" has produced is sifted out, the intermediate portion being passed on to the next roller, and so on. Thus, after it has passed through two or three rollers, branny portions have been largely removed, and the product is white and granular, consisting chiefly of the kernel of the grain broken up into coarser or finer particles, according to the exact number of rollers through which it has passed. To this product of the wheat, in its conditions of coarse or fine particles, the name **semolina** is given. By further operations of rolling, dressing, &c., it may be reduced to the form of flour. Various terms are applied to the different products obtained in the various stages of the milling process. A simple division of the products is into flour, middlings, and bran. Of the bran, even, there are many degrees of fineness. Thin bran is that part of the covering which is often separated before the grain is broken according to one method, that of Mège Mouriés, by damping and rubbing the grain. Then there is long bran, the next outermost coat of the grain. Pollard is a finer bran. Middlings consist of fragments of the kernel of the grain mixed with branny particles, and as they are submitted to further rolling they become reduced and separated by winnowing, &c., from the branny portions. Tailings is a term applied to lighter portions of the wheat, separated out by winnowing, consisting of parts of the kernel adhering to the bran, which, by subsequent breaking, become separated, so that finally the tailings become reduced to simple bran. Sharps is the product a stage behind the fine flour, in which the starchy part of the grain is yet in particles, and in which some of the outer parts of the seed are still present, though in a fine state of division. Fine sharps is also called seconds flour, and coarse sharps thirds. It is worth noticing those different varieties, because their chemical composition is different. The chief difference consists in the varying proportion of nitrogenous material which each contains. As already noted, the outer parts of the grain are richest in nitrogenous or albuminoid material, and the kernel is richest in starch. Accordingly, as the coarser portions are removed, and the stage of fine white flour is reached, the proportion of albuminous material falls, and that of starch rises, so that the finest white flour, consisting essentially of the heart of the grain, is poorer in tissue forming and repairing material than the inferior qualities of flour, in which a larger proportion of the outer parts of the wheat is present. This is well shown in the following note, taken from Church, of the relative proportion of the nitrogenous material in one pound of some of the products named :—

			oz.	grs.
1 pound of	finest flour	contains of nitrogenous material,	1	297
,,	middlings	,, ,,	2	105
,,	coarse sharps	,, ,,	2	246
,,	fine pollard	,, ,,	2	210
,,	long bran	,, ,,	2	182

In the outer parts of the grain, also, the saline constituents reside in greatest abundance. Thus they amount in fine flour to 50 grains in the pound, in middlings to 147 grains, in fine pollard to 399 grains, and in long bran to 1 ounce 60 grains. Much of the saline material consists of phosphates, of great value in the formation of bone. Thus a seconds flour is superior to the finest quality from a nutritive point of view, because of the larger proportion of material useful for the repair of all the tissues and the formation of bone. It might also be said, at least so far as the chemical composition is concerned, that a still lower quality of flour possessed a higher nutritive value. But when one takes coarser kinds, the element of digestibility enters into the question. It has been shown, by direct experiment, that when bread made from the finest flour was consumed, less was expelled from the alimentary canal in the form of waste than when bread of coarser qualities was eaten. It is not possible, therefore, to make the chemical constitution the only test of the nutritive quality of the flour. The following table shows the differences that have been indicated :—

	Fine Flour.	Whole Meal.	Bran.
Water	13·0	14·0	14·0
Nitrogenous	10·5	21·8[1]	15·0
Fat	0·8	1·2	4·0
Starch, Sugar, &c.	74·3	59·7	44·0
Fibre	0·7	1·7	17·0
Ash	0·7	1·6	6·0

[1] Of which a large portion is not useful for nutrition.

Flour consists, it appears from the table, to the extent of three-fourths of starch, and contains only a tenth of nitrogenous material, with less than a hundredth part of fat. The starch may be separated from the nitrogenous material by a comparatively simple process. The flour, made into a stiff dough with water only, is placed on a sieve or on a piece of muslin tied over the mouth of a wide bowl, and worked with the hand while a stream of water flows upon it. The starch granules pass through the muslin or sieve with the water, and the process is continued till all the granules have been washed away, and the water passes through quite clear. The starch may be recovered from the bowl by decanting the water, as it does not dissolve in cold water, and then drying it. There remains on the muslin a yellowish, semi-transparent, adhesive substance, somewhat elastic, to which the name **gluten** is given. When dried it is a horny, brittle substance. This may be made without further preparation into small rolls or buns and baked in the oven, when one has **gluten bread**. It swells greatly during baking, so that very small pieces are used for each roll. It is this bread which is used in the treatment of diabetes (p. 303), in which all sugar is cut off from the dietary, and necessarily also all starch, since starch is converted into sugar in the body. There is no grain other than wheat which yields a flour containing so much gluten. It is the presence of the gluten that enables wheat flour to be so readily made into a dough, which can be baked into loaves. Its adhesive and ductile qualities render it possible to bake it into various forms which will retain the shape given to them. But this gluten, or vegetable albumin, as it is also called, is not a simple substance like egg albumin. It appears to consist of no less than four albuminous bodies. One of these is gliadin, "which is like a clear yellow varnish, and so tenacious that it may be drawn into threads." So that it is this constituent of the gluten specially which gives the tenacious character to dough.

Bread is simply baked dough, made with flour and water, a porous or spongy character having been given to the mass. This spongy character is produced by a variety of methods. The one in ordinary use is that of fermentation, and consists in the introduction into the dough of some yeast, which in course of its activity produces alcohol and carbonic acid gas. If the yeast has been thoroughly mixed with the dough the carbonic acid gas is produced uniformly throughout the mass, and thus causes the dough, because of its tenacious character, to rise with the pressure of the generated gas, and to be permeated by a multitude of minute spaces. The gas escapes from the bread, but the fine spaces or cavities remain permeating the bread and conferring a porous character upon it. The nature and action of yeast are described in the next section, in the portion devoted to the consideration of the manufacture of alcohol. Various kinds of yeast are used for this purpose. Barm is the yeast used by brewers to excite fermentation for the manufacture of beer, and is used by some to produce the best-flavoured bread. Leaven is obtained from old dough. If a paste be made of flour and water, and set aside in a warm place, fermentive changes will arise in it, and if a portion of this dough be mixed with fresh dough it will excite the change quickly in the latter. The cause of the fermentive change is really the same in leaven as in yeast, the action of the yeast plant, which in the former case has been deliberately introduced, and whose introduction has in the latter case been left to chance. The leaven is, on that account, apt to become the scene of abnormal forms of fermentation of an acid kind, and to produce a souring action on the dough rather than a true leavening action. Bakers' yeast is a preparation of boiled and mashed potatoes to which yeast and flour are added, the potatoes affording nutriment for the growth of the yeast. Patent yeasts are now extensively employed. They are produced by scientific methods from malted grains, as in the production of alcohol; mixed with starch and filtered, the yeast can be pressed into cakes, in which form it is easily kept and transported. Such yeasts are imported principally from France, Germany, and the Netherlands.

In the making of bread a portion of the flour is mixed with the ferment with water and salt. The mass produced is set aside, and forms the "sponge." It is left for several hours, during which fermentation occurs and the sponge rises, and latterly collapses by escape of gas. Thereafter the remainder of the flour, with additional salt, is incorporated with the sponge, forming the dough, which is thoroughly kneaded. It is then allowed to lie for a couple of hours longer, when it is turned out of the trough, and weighed out into the required masses, which are shaped into loaves for the oven. With the heat of the oven the gas, entangled in the dough, expands and causes a further "rising" to take place; and with the continuance of the heat the yeast is killed, so that no further fermentation can occur. The dough can be made porous by other methods not involving fermentation. Tartaric acid and carbonate of soda mixed with the dough will cause it to rise, because the chemical action of the two produces carbonic acid gas, which expands the bread. This process was devised by Dr. Whiting in 1836. He, however, used hydrochloric acid added to the water, the carbonate of soda being mixed with the flour. In 1845 tartaric acid was substituted for hydrochloric. Baking-powders are made of mixtures of tartaric acid and soda, and sometimes they are coloured yellow with turmeric and called *egg-powders*, though they are quite innocent of any acquaintance with eggs. Another method of raising bread was patented by Dr. Dauglish in 1856. It consists in making the flour into dough with water charged with carbonic acid gas, and the bread produced was on that account called "aerated bread." The carbonic acid gas is produced first, and is dissolved in water under pressure, a simple aerated water being produced. In another strong iron vessel called a "mixer" the flour is made into dough with the aerated water by the action of "arms" worked by machinery. The gas passing off from the water permeates the bread, and when the dough shaped into loaves is turned out of the machine, it expands still further. During the whole operation it is untouched by the hand. From the absence of the chemical changes occurring in fermented bread, the flavour is not so complex, nor so enjoyable, as that of the fermented variety. The addition of carbonate of ammonia to dough will also cause "rising" to occur by the production of vapour of ammonia, owing to the heat, and its dissemination through the dough. It will be noticed that whatever method is employed, the chief result desired is that of permeating the bread with air spaces to confer lightness and sponginess upon it, and render every particle of it more easily accessible to the action of the digestive fluids, and therefore more readily digestible.

There are considerable chemical differences between ordinary bread and the flour from which it is made, changes produced by the process of baking, and the changes set up by the fermentation. The baking causes the starch grains to swell and burst, rendering their contents accessible to the digestive fluids. The albuminous substances are coagulated, and can no longer be separated from the starch. Some of the starch is changed into dextrin, a form of sugar, by the action of heat, and this specially occurs in the crust. Some of the starch will also be converted into sugar by fermentive changes which occur if the flour contains any of the cerealin of the grain. Bread contains, therefore, always more sugar than is present in flour. While the bulk of alcohol produced by the process of fermentation escapes, an appreciable quantity can always be detected in fresh bread. "A pound loaf would yield, if very carefully distilled, about twenty-two grains (considerably less than a tea-spoonful). As the bread gets staler the quantity decreases." The following table shows the composition of fine white bread:—

	Fine White Bread.
Water	38·51
Nitrogenous	6·82
Fat	·77
Starch, Sugar, &c.	52·34
Fibre	·38
Saline	1·18

The amount of water present in bread should not exceed that stated in the table. But supposing flour were made to take up more water than usual, it is evident that a larger quantity of bread than usual could be produced from a given quantity of flour, to the profit of the baker. This is one of the chief reasons for the adulteration of bread with alum, rice, &c. Dr. Letheby says, "in practice 100 pounds of flour will make from 133 to 137 pounds of bread, a good average being 136; so that a sack of flour of 280 pounds, should yield 95 four-pound (quartern) loaves. The art of the baker, however, is to increase this quantity, and he does it by hardening the gluten through the agency of a little alum, or by means of a gummy mixture of boiled rice, three or four pounds of which will, when boiled for two or three hours in as many gallons of water, make a sack of flour yield 100 four-pound loaves. But the bread is dropsical, and sets soft and sodden at the base, where it stands." The method of detecting these adulterations is mentioned on p. 597.

Bread loses weight by evaporation of water. The 4-lb. loaf loses on an average

In the first 24 hours	1¼ ounce.
,, 48 hours	5 ounces.
,, 60 ,,	7 ,,
,, 70 ,,	8¾ ,,

—(Blyth.)

Bran bread, and specially whole-meal bread, show a larger proportion of nitrogenous constituents, but for reasons already stated, it is not likely that it yields any appreciably larger quantity of nourishment to the body, though for many persons its action on the bowels is of considerable value.

Malted bread is bread prepared with malt, by means of which a considerable quantity of the starch of the flour is converted into sugar, and by this means the digestive organs are relieved of some of the work they would otherwise be called on to perform.

Biscuits are usually unleavened. The simplest sailors' biscuits, for example, are made with flour and water, and with, perhaps, a slight addition of butter. Fancy biscuits are made with special qualities of flour, and contain, besides the ordinary ingredients, milk, salt, butter, sugar, perhaps eggs, and any special flavouring or colouring agent. They are sometimes "lightened" by means of carbonate of ammonia. Because of their dryness they keep well. They are as a rule exceedingly wholesome, and contain more nutriment than an equal weight of bread. Biscuit powder boiled with milk, or a mixture of milk and water, and slightly sweetened is a useful food for infants. Tea biscuits ground by means of a rolling-pin may be used for this purpose.

Passover cakes are a form of unleavened bread. They are made of flour and water only.

Semolina, as already described, consists of the heart of the wheat grain in a yet granular condition. It is largely starchy in composition, and is not, therefore, suitable as a main article of diet. It is, however, usually made from the hard wheats of warm climates, and thus contains a larger quantity of nitrogenous constituent than that made from ordinary white wheat.

Macaroni, Vermicelli, and Cagliari Paste are also prepared from the hard wheat. A paste is made of flour and hot water, and is pressed through moulds to produce the pipe form, or stamped out into the desired shape. It is then dried. Such preparations of wheat contain a much higher proportion of nitrogenous material than bread. They are exceedingly nourishing in consequence, if less digestible because of their close texture.

Oats are derived from an annual herbaceous grass, of the tribe *Aveneæ*. The common oat is derived from the *Avena sativa* or *orientalis*. It is a hardier plant than wheat, ripening well in colder climates. Grown in England as food for horses, it was long the main, and in a large number of cases the only, food of the Scotch peasant. A bag of oatmeal was the only ration the Scotch clansman provided himself with, when he sallied forth with his clan to a fray, and the Scotch Highlanders have been considered as one of the most martial and enduring races on record.

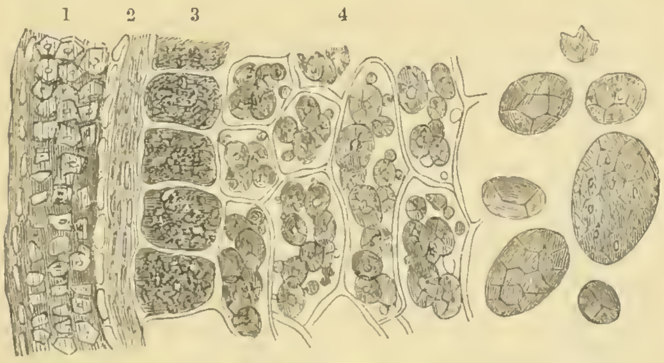

Fig. 195.—Section of Oat Grain—highly magnified. 1 and 2 are the membranes enveloping the seed, corresponding to the bran of wheat. 3 is the surface layer of the seed itself. 4 are the compartments containing starch granules, into which the substance of the seed is divided. To the right of the fig. are shown some of the granules of starch from the interior, more highly magnified.

Fig. 195 shows a section of the oat grain, resembling that of wheat, the kernel consisting of compartments filled with starch grains, and being surrounded by several coats richer in nitrogenous material. The husk adheres to the grain very closely. For its removal the grain is dried on a kiln, and then by grinding in a mill the grain is broken up, and the husks removed. The oat broken up into coarse particles is called groats or grits, these on being ground form oatmeal. One hundred pounds of oats yield of—

Oatmeal	60 pounds.
Husks	26 ,,
Water	12 ,,
Loss	2 ,,

The composition of a fresh sample of Scotch oatmeal, which possesses the largest nutritive properties, is shown in the following table:—

	Scotch Oatmeal.
Water	5·0
Nitrogenous	16·1
Fat	10·1
Starch, &c.	63·0
Fibre	3·7
Saline	2·1

The small proportion of water is noticeable. The nitrogenous constituent consists of two substances, plant casein or avenine, and gliadin. The former resembles in properties one of the albuminoids of wheat, and in composition the legumin of peas and beans; the latter is in less quantity than in wheat, and thus a dough cannot be made of the flour of the meal, so that oat bread cannot be made. Oatcakes and biscuits are, however, baked, but because of the very slight tenacious character of the meal, they are very short. A very important element in the composition of oatmeal is the large proportion of fat. No other cereal contains such a large quantity; Indian corn is the only other which yields a meal at all approaching to it. It is this, as well as the larger proportion of the nitrogenous material, and the small percentage of water, that makes oatmeal so exceptionally wholesome and nutritious. The salines consist largely of salts of potash and phosphorus.

A fine oat-flour is now prepared by several millers in Scotland, which contains all the nourishing ingredients of the meal. It is as yet sold at too high a price to make it a very extensively used food-stuff. It forms an admirable diet, when boiled with water, for children. It may be given to them with milk as soon as it becomes desirable to supplement the mother's milk, by the sixth or even the fourth month of life, and it may be made an exclusive diet for them up to the end of the eighteenth month, or for any longer time. One often finds it stated that wheat-flour and oatmeal are, weight for weight, pretty nearly on a level as regards nourishing qualities. This is true of inferior qualities of oatmeal. Oats grown in

England, for example, are much inferior in nutritive constituents to the finest Scotch oatmeal. It is not true of the latter, which in point of nourishing constituents, ease of cooking, and digestibility far surpasses every other kind of food-stuff.

The husks of oats with the adherent particles of the kernel are employed to make what used to be a very popular dish in Scotland and South Wales, and called **sowans, seeds,** or **flummery.** The husks are steeped in water for two or three days, till by the action of a ferment, present in small quantity in the coverings of the seed, fermentation arises. The liquid is skimmed and then boiled down to the thickness of gruel. It is called **sucan** or **llymru** in Wales. When it is boiled down for a longer time, it forms a firm jelly on cooling resembling blancmange, which is very light, bland, and nourishing. It is called **budrum.** **Brose** is prepared by simply stirring in boiling water with the meal. It is eaten with milk. The Scotch farm labourer, with whom it was often the chief if not the only meal, found it more "staying" than porridge because of being less rapidly digested. The water used may be that in which beef has been boiled, and then **beef brose** is the product, or that in which cabbage or kale has been boiled, and the product is **kale brose.** **Gruel** is made by steeping groats or oatmeal in cold water for several hours, with occasional stirring. The mixture is then well stirred and the water poured off carrying with it the flour of the meal, all large particles being left behind. This liquid is then boiled with constant stirring for 10 or 15 minutes. Milk may be added to it and boiled with it. Sugar, butter, and flavouring agents, such as ginger or raisins may also be added, according to desire. The product is an exceedingly soft, pleasant, and nourishing drink, which is in much favour for the domestic treatment of slight colds in the head, and simple feverish colds, or after hard work and exposure. The common prescription in such circumstances is a hot foot-bath, a gruel, and to bed.

Porridge is made by stirring the meal into boiling water. The water in the pot is allowed to boil first, then a handful of meal is taken, and the meal allowed to fall in a slow stream on to the water, which is continually stirred the while with a wooden stirrer called a porridge-stick or spurtle. From three-quarters to an imperial pint of water and a good handful of meal, about four ounces, are about the quantities to make a good dish for one person. Salt is added to taste. The mixture is kept boiling for fully twenty minutes, by which time the particles of meal have become much swollen and the porridge is thick. Of course it may be made of any desired degree of thickness. The best way to eat it is with cream or milk. Some persons prefer to eat it with butter, or not to add salt and to use sugar, syrup or treacle as an adjunct. But porridge, if properly made, and cream is the dish *par excellence.* The Scot who crosses the border, or the German Ocean, or the Atlantic, and seeks to have his national dish to breakfast, is seldom surprised that its popularity is pretty nearly confined to Scotland. As one finds it served in London or Continental hotels, or in the saloons of Atlantic liners, it is, as a rule, an execrable dish. If properly made few fail to relish and enjoy it. Scotch oatmeal is usually in larger particles than that made in England, and the porridge made from it is usually more enjoyed. Oatmeal is often alleged to be "heating," this view Pereira thinks arises from prejudice and to be without due ground.

Barley belongs to the tribe *Hordeæ* of the grasses. There are several varieties of it. It was originally a native of Western Asia, is hardier than either wheat or oats, and may be grown in high latitudes. It is used in Britain mainly for the preparation of malt, ales and spirits. In Scotland, in the form of pot or pearl barley, it is used for broth, but not for the making of solid food. On the Continent the meal is added to wheaten flour for bread, and is also largely used alone. It may be used whole after being parched. The grain in section presents an appearance like wheat or oats. The grain ground whole yields barley-meal, and it is also, by a process of rubbing, deprived of its coatings and rounded into the form with which one is familiar. The coarsest form is called pot-barley, and the finest pearl-barley. The composition of barley-meal and pearl-barley is shown in the following table:—

	Barley-meal.	Pearl-barley.
Water	15·06	14·6
Nitrogenous	11·75	6·2
Fat	1·71	1·3
Starch, &c.	70·90	76·0
Fibre	·11	·8
Saline	·47	1·1

Patent barley is made by grinding pearl-barley to powder. Formerly barley-meal was largely employed instead of wheat flour as a food for the people. Its nitrogenous constituent resembles that of wheat. Its salts are rich in potash and phosphorus. It is both less nourishing and less easily digested than wheat or oats, and is not, therefore, equal to them as a food-stuff. The bread it yields is heavy. **Barley-water** is a pleasant, cooling drink in feverish attacks. It is made as follows: take two ounces and a half of pearl-barley, first wash away with water the foreign matters adhering to the seeds, then add half a pint of water and boil for a little while. This liquid being then thrown away, pour on them four pints (imperial) of boiling water, boil down to two pints and strain. It is frequently flavoured with sugar and sometimes with lemon-peel. (Pereira.)

Malt is produced from barley by causing the grain to germinate by means of moisture and warmth. By the activity of a ferment, contained in the coatings of the seed, some of the starch of the grain is transformed into sugar. This is a process preliminary to brewing, for under the influence of an added ferment—yeast—this sugar is further converted into alcohol and carbonic acid gas. This is described in more detail in the succeeding section.

Rye is derived from the *Secale cereale*. It is grown in the eastern counties of England, mainly for malting purposes. The malt used in the manufacture of Hollands is made from rye. It flourishes in soil too poor for wheat. It is extensively used for the production of bread in Northern Europe, the well-known black bread being made from it. Mixed with wheat flour, rye flour is used for the same purpose, two parts of wheaten flour and one of rye flour. The bread is dark and sour and close, though nourishing. The general appearance of a section of the seed resembles that of wheat and oats. Deprived of the husk it is ground into meal and flour. The composition of rye flour and rye bread is shown in the following table:—

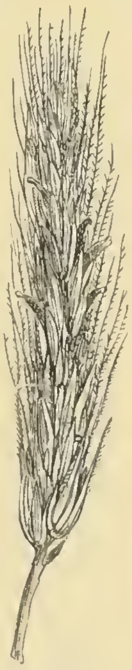
Fig. 196.—Spurred Rye.

	Rye Flour.	Rye Bread.
Water	13·0	44·02
Nitrogenous	10·5	6·02
Fat	1·6	·48
Starch, &c.	71·0	47·87
Fibre	2·3	·30
Saline	1·6	1·31

The saline constituents are, like those of the other grains, rich in potash and phosphorus.

It is clear from this table, comparing it with that of wheaten bread, on p. 562, that wheaten bread and rye bread are much alike in nourishing quality, though the former is slightly more digestible. The latter keeps better and does not so quickly become dry and stale.

In Russia rye is used for the production of a fermented liquor called **quass**.

Rye is subject to the attack of a fungus called ergot of rye, or *Secale cornutum*, and the rye attacked is called, from the appearance the fungus produces, spurred rye (Fig. 196). It attacks the ear when it is in flower, the young flower being covered with a white mass, consisting of the spores of the fungus. Ergot is employed in medicine and is an exceedingly valuable drug, but when spurred rye is used for food serious and even fatal consequences are liable to ensue, gangrene of the extremities being produced by the frequent use of the diseased grain. Ergot also attacks wheat and maize.

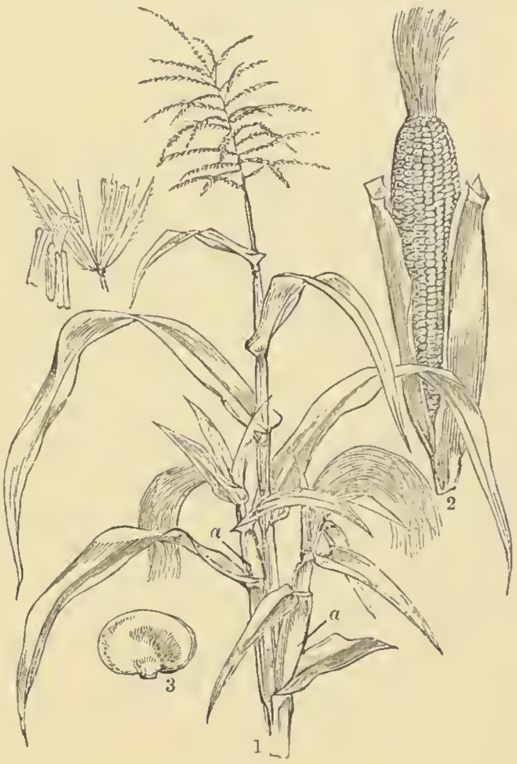

Fig. 197.—Maize or Indian Corn.
1. The grass. *a a*, Position of the cob. 2, The cob. 3, The corn.

Maize or **Indian Corn** (Fig. 197) belongs to the tribe *Maydeæ* of the grasses, and is called *Zea Mays*. It is native to tropical America, but is now grown also in Africa, Southern Europe, Germany and India. It grows to the height of 6 to 10 feet, the grain growing on a cob, as shown in the figure, several cobs being on each stem. The fruit is in this form called **corn-cob** in America, and is often eaten green, or boiled in milk, or roasted and eaten with other foods. **Pop-corn** is the grain of a small variety of maize burst by the agency of heat. When mature the whole grain may be used after being parched. It is also ground into a meal, skin and kernel together, the coverings being more easily ground than those of other grains. The grains deprived of the husk and roughly ground yield **hominy, samp,** or **grits,** according to the size of the particles. It needs much boiling, and is the better of being steeped for some hours previous to cooking. The composition of Indian-corn meal is as follows:—

	Indian-corn Meal.
Water	17·1
Nitrogenous	12·8
Fat	7·0
Starch, &c.	60·5
Fibre	1·5
Saline	1·1

It will be noticed from the table that maize meal contains a much larger quantity of nutritive material than all the cereals, oatmeal alone excepted. The quantity of fat present is very high. The nitrogenous ingredient is also abundant, though nearly 2 of the 12·8 per cent is of a kind not available for nourishment to the body. Phosphoric acid and potash are the chief constituents of the saline ingredient.

Maize meal cannot be made into a light bread, but it is cooked in the form of cakes or puddings or prepared as a porridge. Thus in the United States of America a dish called **mush** is prepared from it by boiling. The same in Italy is called **polenta**; a finer meal is termed **polentina. Corn-lob** is a maize porridge made with milk. The brown bread of New England is made of a mixture of maize and rye meal.

Cakes, called **Johnny-cakes,** or hoe-cakes, are made of it and are baked before the fire on a board or on a plate in the oven. In Mexico **tortilla** is the term used for them. They are eaten hot with milk, or butter, treacle, &c.

The objection to maize meal is its flavour, due to the presence of a bitter principle. By various methods of manufacture this principle and the nitrogenous constituents are removed, leaving only the starch of the grain in the form of a fine white powder, called corn-flour, maizena, cornena, Oswego flour, &c. It is really pure starch, and will be considered in detail among the starches.

Rice (*Oryza sativa*) belongs to the tribe *Oryzeæ* of the grasses. It is native to India, and is also grown in China, and the East generally, in Central America, and the southern parts of Europe. It requires a warm climate for its successful growth, and the fields are usually irrigated. There are many varieties, the grains differing in size, colour, and general appearance, that grown in South Carolina being most esteemed. It is cut down and threshed like wheat, and the grains inclosed in the husk are known as **paddy** or **rough rice.**

The fig. 198 shows a section of the grain. It is the main food of more than a hundred millions of people. It is husked by passing it through a mill, and then the husks are winnowed out, broken rice is separated, and the cleaned kernel is that part sold as rice. Its composition is shown in the table on p. 558, from which it appears to be deficient in nitrogenous material and more than usually rich in starch, and deficient in fat. It is the least nutritious of the cereals, and is not a perfect food alone, because of its deficiency in tissue-repairing material, a deficiency made up by the addition to the diet of some kind of flesh meat, or eggs as in rice-pudding, and to a slight extent by milk. Because of its richness in starch rice is used for the production of that article. When cooked alone it should be steamed, not boiled, to prevent the removal of any of the nitrogenous constituents.

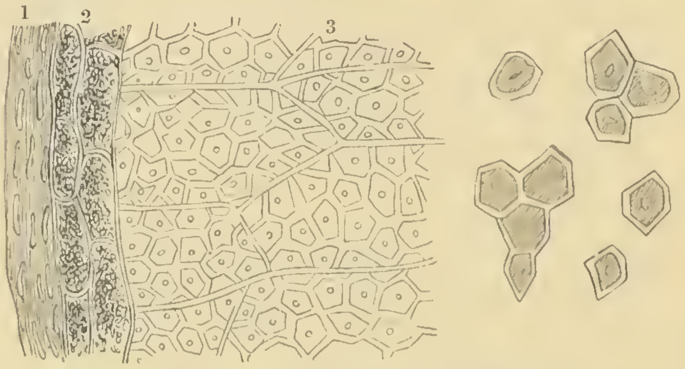

Fig. 198.—Section of Rice Grain—magnified.

1 and 2, Outer coats; 3, Starchy kernel. To the right are seen granules of rice starch, more highly magnified.

Ground rice and rice flour are two products, the latter being often used to adulterate other less cheap kinds of flour, such as that of wheat.

Millet belongs to the species *panicum*, of which there are many varieties. It is native in the East Indies, and is used as food in China and among eastern races, chiefly, that is, in hot countries. The grain is used in this country for feeding poultry and other domestic animals. Its composition is shown on p. 558. Its nutritive value is reckoned as about equal to rice. In the *Lancet* of November 9, 1872, the result of an experiment made with millet is recorded. It was made on a sailor, sentenced to solitary confinement for forty-nine days. He was fed solely on millet and water. "He entered prison on the 3d April, when he weighed 146 lbs. 8 oz., and he left it on the 22d May, weighing 147 lbs. 14 oz. Throughout the confinement he never weighed so little as on the day he commenced, and this in spite of the depressing effects of solitude and the monotony of his food. He ate about 3½ lbs. of millet daily; and when he left prison he looked, as he said he felt, perfectly well. The experiment shows that the grain, which has been chosen by the people as their principal food, is capable of maintaining for a considerable length of time perfect health under very depressing circumstances."

Fig. 199.—Millet.

A fermented beverage, called **bouza**, or millet-beer, is prepared from the grain in Tartary, by pouring hot water over a portion of fermented seed. In Sikkim also such millet-beer is in general use. The millet seed is moistened and allowed to ferment for several days. An infusion is then made with hot water, which is sucked through a reed from bamboo jugs. It is said to taste like negus of Cape sherry, rather sour, and though weak a grateful beverage on a hot day's march.

Dhurra, Dhoora, Dari, Sorghum vulgare, or **Sorgho Grass** is a species of millet, Indian millet, but it belongs to a tribe of grasses different from the true millets, namely, *Andropogoneæ*. It is a tall handsome grass which is largely grown in India, Egypt, Algeria, and the interior of Africa, and to some extent in the south of Europe. The grain is white and larger than millet. It is used in this country for feeding cattle and poultry. Its composition is shown on p. 558, from which it appears to be more nourishing than rice, but to contain less nitrogenous material than wheat, though much more fat.

Fig. 200.—Quinoa.

Buckwheat is not a grass, but belongs to the natural order *Polygonaceæ*. It is a native of Central Asia. In France it is called **Saracen wheat**, having been introduced into Europe by the crusaders. In Norfolk and Suffolk it goes by the name of **brank**. It is used in England for feeding game, and sometimes is given to horses. The husk of the seed requires removal before use, and the composition of the grain deprived of the husk is shown on p. 558. It is rich in all the constituents of nitrogenous material, starch and fat. It does not give a tenacious dough for the making of bread, but may, when ground, be cooked as porridge, or made into thin cakes, which is the favourite method of cooking it in America. They are eaten hot with honey or other savoury substance.

Quinoa (Fig. 200) is a seed yielded by a plant, the *Chenopodium Quinoa*, growing in the high table-lands of Chili and Peru. It forms the principal food of the people of the districts where it grows. The order to which it belongs includes the spinach and the beet. It is said by Johnston to be very nutritious, its flour approaching very nearly to oatmeal in composition, and to have formed the chief food of the Peruvian nation. There is a sweet and a bitter variety of it. The meal can be made only into cakes.

LEGUMINOUS SEEDS.

Average Percentage Composition of Peas, Beans, and Lentils.

	Peas.		Broad Beans.		Kidney Beans.		Lentils.
	Green.	Dried.	Green.	Dried.	Green.	Dried.	
Water......	80·49	14·31	86·10	14·84	87·36	13·60	12·51
Nitrogenous (nutritive)	5·75	19·98	4·67	21·30	2·77	20·81	22·31
Nitrogenous (non-nutr.)		2·65		2·36		2·31	2·50
Fat	0·50	1·72	0·30	1·63	0·14	2·28	1·85
Starch, &c.	10·86	53·24	6·60	49·25	8·02	53·63	54·78
Fibre	1·60	5·45	1·69	7·47	1·14	3·84	3·58
Saline......	0·80	2·65	0·64	3·15	0·57	3·53	2·47

The natural order Leguminosæ includes peas, beans, and lentils as the chief examples used as food. They belong to the papilionaceous division of that order, so called from the butterfly appearance of the flower (Latin *papilio*, a butterfly). They are all characterized, as the above table shows, by the unusually large proportion of nitrogenous material, excelling beef, mutton, and fish in this respect, and still more markedly other vegetable products. This is strikingly shown in Plate IX. One must not, however, ignore the fact that this nitrogenous constituent is not all available for nutriment, and that a very much larger proportion of waste attends their consumption than that of animal food. This is further referred to on p. 604. Their richness in nitrogen makes them valuable associates in a diet, abounding rather in starch or fat. As an example of the former take rice and peas or beans, and of the latter, bacon and beans or peas.

Peas. There is the garden pea (*Pisum sativum*) and the field pea (*P. arvense*), the latter grown for feeding cattle. The garden pea is native to the south of Europe. The sea pea (*P. maritimum*) is also used in some parts of Europe as a food. The chick pea or gram (*Cicer arietinum*) is grown largely in the North-western Provinces of India, where it is commonly sown with barley and wheat. "The tops of the shoots are much relished as a vegetable, the flavour being possibly enhanced by the oxalic acid which it is the curious property of the leaves to exude." It suffers greatly by frost, and is not, therefore, a profitable growth in colder climates. It is also cultivated in the south of Europe.

It will be noticed from the table that peas in the fresh state are much less nourishing than when old and dried. They are, however, much more tender and digestible. The skin is particularly difficult of digestion. The chief nitrogenous constituent of peas, beans, and lentils, is a substance called plant-casein or legumin. It is their richness in legumin that gives them the tendency to produce flatulence and colic, when they are eaten to any extent. The saline constituent is richer in potash and lime than that of the grains, but poorer in phosphoric acid. Peas and other members of the same family contain a bitter principle, removable by soaking in water to which a little ordinary washing soda has been added. It is recommended to soak them in this for some time before cooking, the liquid being thrown away. They require prolonged, slow boiling, even when ground. The tough skin is removed in split-peas. The composition of dried peas ground into meal is stated as follows:—

Percentage Composition of Dried Pea-meal.

Water	8·10
Nitrogenous	28·10
Fat	2·97
Starch	50·17
Fibre	8·12
Saline	2·54

Pease-meal is, subject to the remarks that have been made as regards digestibility, an exceedingly valuable article of diet. Stirred with boiling water to a fine thick paste, and with added salt, it forms brose. But it would be of much greater nutritive value, and milder in action on the stomach and bowels, if made into a porridge, by prolonged boiling in the manner of oatmeal porridge. In Germany a pea sausage and pea tablets are prepared from pease-meal and dried and powdered meat, the mixture being compressed by strong pressure. It has been found a very useful ration for the soldier in campaigning. It contains over 31 per cent of nitrogenous, 3 of fatty, and 47 of starchy material, and 2 lbs. of it daily would supply a diet for hard work. Tinned peas are prepared by being submitted to the influence of a high temperature after being placed in the tins, and then the tins are hermetically sealed. Often they have their colour improved by being previously boiled in copper vessels. Though it has not been found positively that this practice is injurious, it is highly undesirable.

Beans.—The beans commonly used are the haricot, kidney, or French beans (*Phaseolus vulgaris*), and the broad or Windsor bean (*Vicia Faba*). The horse-bean is a variety of the latter. The broad bean is used generally in the fresh state, being grown in gardens, but is also dried and preserved. The haricot bean is a native of India. It is largely grown in Italy and France and was introduced into England in the sixteenth century. The scarlet-runner (*Phaseolus multiflorus*) is a variety of the same plant. It also is used as a green vegetable cooked in its pod. It is native to Mexico, and was introduced into England in 1633.

Haricot beans ought to be a much more popular food-stuff in Britain than they are. With rice or fatty food-stuffs such as bacon they make a well-proportioned and nourishing diet.

"For our labourer," says Sir Henry Thompson, "probably the best of the legumes is the haricot-bean, red or white, the dried mature bean of the plant whose pods we eat in the early green state as 'French beans.' For this purpose they may be treated thus: Soak, say, a quart of the dried haricots in cold water for about twelve hours, after which place them in a saucepan, with two quarts of cold water and a little salt, on the fire; when boiling remove to the corner and simmer slowly until the beans are tender; the time required being about two or three hours.[1] This quantity will fill a large dish, and may be eaten with salt and pepper. It will be greatly improved, at small cost, by the addition of a bit of butter, or of melted butter with parsley, or if an onion or two have been sliced and stewed with the haricots. A better dish still may be made by putting all or part after boiling into a shallow frying-pan, and lightly frying for a few minutes with a little lard and some sliced onions. With a few slices of bacon added, a comparatively luxurious and highly nutritive meal may be made. But there is still in the saucepan, after boiling the haricots, a residue of value, which the French peasant's wife, who turns everything to account, utilizes in a manner quite incomprehensible to the Englishwoman. The water in which dried haricots have stewed, and also that in which green French beans have been boiled, contains a proportion of nutritive matter. The Frenchwoman preserves this liquor carefully, cuts and fries some onions, adds to it these and some thick slices of bread, a little salt and pepper, with a pot-herb or two from the corner of the garden, and thus serves hot. . . . But haricots are good enough to be welcome at any table. A roast leg or shoulder of mutton should be garnished by a pint, boiled as just directed, lying in the gravy of the dish; and some persons think that, with a good supply of the meat gravy, and a little salt and pepper, 'the haricots are by no means the worst part of the mutton.' Then with a smooth *purée* of mild onions, which have been previously sliced, fried brown, and stewed, served freely as sauce, our leg of mutton and haricots become the *gigot à la bretonne*, well known to all lovers of wholesome and savoury cookery. Next, white haricots, stewed until soft, made into a rather thick *purée*, delicately flavoured by adding a small portion of white *purée* of onions (not browned by frying as in the preceding sauce), produce an agreeable garnish for the centre of a dish of small cutlets, or an *entrée* of fowl. . . . Let me recall, at the close of these few hints about the haricot, the fact that there is no produce of the vegetable kingdom so nutritious; holding its own in this respect, as it well can, even against the beef and mutton of the animal kingdom. The haricot ranks just above lentils, which have been so much praised of late, and rightly, the haricot being also to most palates more agreeable. . . . I do not, of course, overlook in the dish of simple haricots the absence of savoury odours, proper to well-cooked meat; but nothing is easier than to combine one part of meat with two parts of haricots, adding vegetables and garden herbs, so as to produce a stew which shall be more nutritious, wholesome, and palatable, than a stew of all meat with vegetables and no haricots. Moreover, the cost of the latter will be more than double that of the former."

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[1] If the water is hard a little soda should be added to soften it.

In China and Japan cheese is manufactured from a species of bean (*Soia hispida*). The beans are ground, made into a paste, and the vegetable casein is coagulated. It contains a little over 3 per cent of nutritive material.

Lentils (*Ervum Lens*) are extensively grown in Egypt, Algeria, Turkey, and the southern parts of Europe generally, and in the East. Esau's pottage is believed to have been made from the red or Arabian lentil, the finest variety. As sold in the shops the seeds are deprived of the husks and split. They also are highly nutritious, as the table shows.

Ervalenta and **Revalenta Arabica** are mixtures, according to Dr. Hassall, the former of the meal of the French or German lentil with a substance resembling Indian-corn meal, and the latter of the Arabian lentil and barley flour, with the addition of some saline material, chiefly salt. They are sold at a price ridiculously high considering the cost of their ingredients.

TUBERS AND ROOTS.

A tuber is an underground fleshy stem, often considered as a modification of the root. To the class of food-stuffs, tubers and roots, belong the potato, sweet-potato, yam, Jerusalem artichoke, turnip, carrot, beet-root, parsnip, radish, salsify.

The composition of the chief of these, mainly as given by Church, is shown in the following table:—

Average Percentage Composition of Potatoes, Carrots, Turnips, &c.

	Potato.	Sweet-potato.	Yam.	Jerusalem Artichoke.	White Turnip.	Carrot.	Beet-root	Parsnip.	Radish.
Water	75·7	74·0	78·6	80·0	92·8	89·0	82·2	82·0	93·34
Nitrogenous	2·3	1·5	2·2	2·0	0·5	0·5	0·4	1·2	1·23
Carbohydrate (Starch, Sugar, &c.)	19·7	20·2	16·3	14·4	4·0	5·0	13·4	8·7	3·79
Fat	0·3	—	0·5	0·5	0·1	0·2	0·1	1·5	0·15
Fibre	1·0	2·8	0·9	2·0	1·8	4·3	3·0	5·6	0·75
Saline	1·0	1·5	1·5	1·1	0·8	1·0	0·9	1·0	0·74

The large percentage of water in all these food-stuffs at once attracts one's notice, and is graphically shown in Plate IX. Turnip and carrot, in particular, have a very high percentage of water. Radishes resemble carrots in composition. In the next place it is noticeable that all of them are very deficient in flesh-forming and tissue-repairing material. The chief nutriment in them, possessed in greatest amount by the potato, is the carbohydrate ingredient, starch, &c. The proportion of saline ingredients, however, compares very favourably with that of grains.

Even the small amount of nitrogenous material is not all available as nutriment. A considerable proportion of it is found not to be of an albuminoid or proteid character. Thus the 2·3 per cent in the potato consists to some extent of substances belonging to the class of alkaloids, to which class such active principles as quinine, strychnine, etc., belong. Thus, in the potato there is one of them, namely, solanin, which, though nitrogen enters into its composition, is useless for nourishment. Of the carbohydrate element, while the larger proportion is starch, there is a small quantity of sugar, gum, and a substance called *pectin* or *pectose*, formed, like starch, of carbon, hydrogen, and oxygen, but in different proportions, found in most fruits and vegetables, and forming the basis of vegetable jellies. It is evident from the small total quantity of nutritive material contained in such vegetables as carrot, turnip, etc., that they are useful mainly on account of their flavour, and to some extent also because of their saline constituents, and ought to be considered only as agreeable additions to an otherwise plentiful diet.

Potato (*Solanum tuberosum*) belongs to the natural order *Solanaceæ*, the nightshade order, to which such very different plants as the deadly nightshade, tobacco, belladonna, stramonium, henbane, cayenne, and tomato belong. It is an enlargement of the underground stem, and the "eyes" are the buds of this part of the stem, capable of growing independently when detached from the rest. It is native in Chili, Peru, and Mexico, where it is found growing wild, whence it spread to North America. Brought to Europe by the Spaniards early in the sixteenth century, it was cultivated in gardens. In 1565 Sir John Hawkins introduced it into Ireland, and twenty years later Sir Francis Drake brought it to England. It failed to attract much attention, and a year later was reintroduced by Sir Walter Raleigh. It was many years, however, before it was cultivated to any extent, a century elapsing before it was grown in the open fields, and two centuries before it became popular. The name potato is derived from *batata*, the sweet-potato, with which it had been confounded, though the sweet-potato belongs to quite a different order. It grows well in all temperate climates, and it varies much in composition, according, among other things, to the soil on which it is reared.

In 1845 a disease broke out amongst it, dependent upon a fungus, the *Peronospora infestans*, which attacks the lower surface of the leaves and the stalks, having the appearance of brown patches. It appears in July, and penetrates to the tuber.

The substance of the potato is made up of compartments, filled with starch grains in an albuminous juice. In the deeper layer of the skin of the potato pigment is present, and here also the active principle solanin resides. This probably is the foundation for the popular notion that the water in which potatoes in their skins have been boiled is injurious, and ought to be thrown away. Dry heat, however, destroys the solanin, and it exists, in any case, in such small quantity as to be really too insignificant to be productive of any harm. Many people insist on potatoes being pared for a like reason, but they ought to be boiled "in their skins," as this helps to retain some of their valuable qualities. Salt added to the water in which they are boiled helps to prevent the loss of their saline constituents. These constituents are very valuable. Potash is the chief of them, existing to nearly 55 per cent of the total. There are present also some of the organic acids and notably citric. It is probably to the citric acid and potash salts that the potato owes its power for the prevention of scurvy. This power has been amply proved, though to which actual constituent it is due is not positively known. Cooking by steaming is, however, altogether the best way of preventing the loss of valuable ingredients.

Up to the date of the potato famine in Ireland that vegetable was the chief article of diet, an adult Irishman consuming, according to Smith, ten and a half pounds weight daily, three and a half pounds at each meal. For an example of its usefulness in affording a cheap diet see p. 623. As has been already indicated, it is not alone a suitable diet, because of its deficiency in albuminoid material. Beans or peas would supply that want, and butter-milk also. That would, of course, be done most effectually by beef or butcher's meat of some kind.

Starch is manufactured in large quantity from potatoes (see *British Arrow-root*, p. 586), and by permitting fermentation to occur spirit can also be produced, potato spirit, or fusel-oil (see p. 664), British brandy. By roasting, the starch is partly converted into dextrin, by which means British gum is obtained.

Sweet-potato (*Batatas edulis*) belongs to the *Convolvulus* order and is native to the Malayan Archipelago. It is largely cultivated in America, and also in Algeria and Southern Europe, and is grown in Spain and called the

Spanish potato. It was introduced into Spain before the common potato, and was brought to England by Drake and Hawkins, but has not been successfully cultivated, as it requires a warm climate. Its composition is nearly the same as that of the ordinary potato, but it contains 3 per cent of sugar, which the potato does not possess. It varies in size from 9 to 12 pounds in weight, and in Java is said even to attain to 50 pounds. It is a favourite and wholesome food and is said to possess slightly laxative properties.

Yam is also a tuber, belonging to a species of tropical climbing plants, of the genus *Dioscorea* (Fig. 201). Varieties of it are found in the West Indies (*D. sativa*), East Indies, South Sea Islands, New Zealand, and Japan and China. It cannot be successfully cultivated in England. It grows to a very large size, one tuber being sometimes 30 to 40 pounds in weight. It is not sweet like the sweet-potato, and its composition is very like that of the common potato (see table). Some species are said to possess poisonous properties.

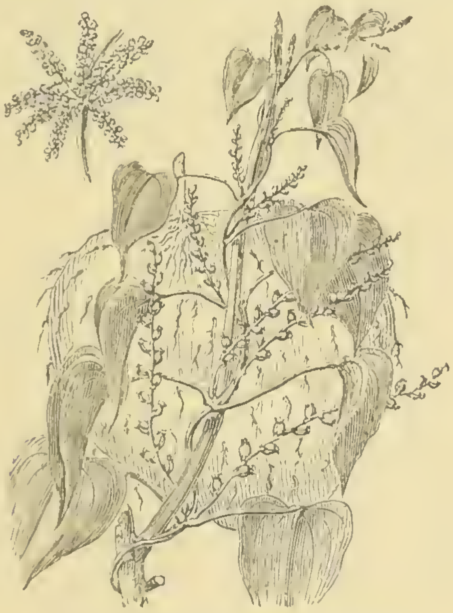

Fig. 201.—Yam (*Dioscorea globosa*).

Jerusalem Artichoke.—This plant belongs to the Sunflower tribe of the natural order *Compositæ*, and its technical name is *Helianthus tuberosus*. The Italian for sunflower is *girasole*, and it is said that in this case Jerusalem is a corruption of girasole. It is not much used in Britain, though it was cultivated in Europe before the potato, and was introduced into England from Brazil in 1617. It is a native of Mexico. The portion used as food consists of oval or rounded masses which form round the root. The carbohydrate of the artichoke consists chiefly of sugar, there is no starch, and consequently there is no mealiness produced on boiling as is the case with the potato.

Turnip.—The turnip as commonly used is the result of cultivation. The Swedish turnip sprang from a wild plant, the *Brassica campestris*, belonging to the natural order *Cruciferæ*. The wild plant has a spindle-shaped bitter root, little resembling the cultivated article. As the table shows it possesses little value as a food. It contains no starch, but a carbohydrate in the form of pectose, and very little albuminous material. A pungent essential oil is one of its ingredients. The **prairie turnip** of North America, which is much used as potatoes are elsewhere, has no relationship to the ordinary turnip. It is a tuber and belongs to the leguminous order of plants.

Carrots are also a product of cultivation, derived from the wild carrot (*Daucus Carota*), of the order *Umbelliferæ*, to which also celery, parsnip, and the poisonous hemlock belong. It grows abundantly in Britain, and is said to have been introduced during the Elizabethan period by the Flemish refugees who settled at Sandwich. The wild plant has a pungent odour and acrid disagreeable taste. Of the carbohydrate 4·5 per cent is sugar, the remainder is gum and pectose. The sugar can be removed in the shape of syrup, and submitted to fermentation to yield spirit. It is said that a substitute for coffee can be made from them, if they are first cut into pieces and roasted.

Parsnip (*Pastinaca sativa*). The parsnip belongs to the same order as the carrot, *Umbelliferæ*. It is a cultivated variety of a wild plant native to Britain. It contains about an equal percentage of sugar and starch, 3 of sugar, 3·5 of starch, the remaining carbohydrate being pectose. Spirit can also be prepared from it, as from carrot.

Beet-root.—There are several varieties of the beet. The common red beet is *Beta vulgaris*. There is the sea-beet (*B. maritima*), supposed to be the origin of the common form and of the sugar-beet, a white variety of *B. vulgaris*, and the field-beet or mangold-wurzel (*B. altissima*). They belong to the order of the goosefoots (*Chenopodiaceæ*). They are native to the south of Europe, and were introduced into Britain in 1656. Of the 13·4 per cent of carbohydrate 10 is sugar; and on this account the beet, especially the white variety, is grown extensively for the production of sugar and the distillation of alcohol. Thus the order of richness in sugar of carrots, parsnips, and beet-root is—

Parsnips, ...	3·0 per cent.
Carrot, ...	4·5 ,,
Beet-root, ...	10·0 ,,

Radish (*Raphanus sativus*) belongs to the natural order *Cruciferæ*, the same order which includes mustard and turnip. It is native to China, and has been cultivated in England since 1548. The roots are spindle-shaped or round like small turnips, and the exterior may be white, red, black, or violet, but the interior is always white. In composition it resembles the turnip, though it is less digestible, specially as it is usually eaten raw. The young leaves are used as a salad and the green pods as a pickle. The horse-radish (*Cochlearia Armoracia*), with a tap-shaped root, is employed in medicine because of the pungent acrid volatile oil, identical with oil of mustard, which it contains.

Salsify or **Purple Goat's-beard** (*Tragopogon porrifolius*) belongs to the order *Compositæ*. There are several varieties, the greater goat's-beard and the yellow, besides the purple. The name is due to the feathery appearance of the seeds. Salsify has a long tapering root, fleshy and tender, and yielding a milky juice. It is usually boiled or stewed, and has a sweetish taste like parsnip. It is also beat up with potatoes, after being boiled, and fried in small cakes, and from its taste when so cooked it is called the "oyster plant."

In Chili, Peru, and Bolivia there are several plants grown for their tubers, which are used for food, such as *Oxalis crenata, Oxalis tuberosa*, and which become mealy like potatoes on boiling. And there are many others of a like character in different parts of the world which are largely used as potatoes or yams.

HERBACEOUS ARTICLES.

Under this head are included the shoots, stalks, leaves, fruit, and seed of various plants, and sometimes the whole plants. The composition of some of the chief of them is shown in the following table:—

Average percentage Composition of Cabbage, Sea-kale, Lettuce, &c.

	Cabbage.	Sea-kale.	Savoy.	Cauliflower.	Spinach.	Lettuce.	Celery.	Water-cress.	Onion.	Asparagus.	Parsley.	Rhubarb.
Water	89·97	93·3	87·09	90·39	90·26	94·33	93·3	93·2	91·0	93·32	85·55	95·1
Nitrogenous	1·89	2·4	3·31	2·53	3·15	1·41	1·2	1·7	1·5	1·98	3·66	0·9
Carbohydrate (starch, sugar, &c.)	4·87	2·8	6·02	5·01	3·34	2·19	3·8	2·9	4·8	2·74	7·44	2·4
Fat	0·20	—	0·71	0·38	0·54	0·31	—	0·2	0·2	0·28	0·22	—
Fibre	1·84	0·9	1·23	0·87	0·77	0·73	0·9	0·7	2·0	1·14	1·45	1·1
Saline	1·23	0·6	1·64	0·82	1·94	1·03	0·8	1·3	0·5	0·54	1·68	0·5

It is convenient to group these numerous vegetables together, though they belong to widely different orders of plants, because the nutritive value of all of them is alike comparatively low, and, in the main, their value as food-stuffs depends upon the variety and flavour they impart to a meal, and also largely upon the salts and acid which they convey to the body. On this last account they are very useful in the prevention of scurvy. They are also distinguished from food-stuffs already considered in possessing chlorophyll, the green colouring matter of plants. Many of them possess also peculiar essential oils, usually of a pungent character, which confer upon them a peculiar flavour and sharpness. They all possess a very large proportion of water; and though many contain a larger proportion of nitrogenous material than potatoes and other vegetables already considered, they show a falling-off in the carbohydrate element. Of this element the large proportion in most of them is sugar. Thus in cabbage 2·29 of the 4·87 per cent is sugar; in celery 2·2 of the 3·8 per cent is sugar; in cauliflower the sugar is 1·27 per cent; in savoy, 1·29; in parsley, 0·75.

Cabbage belongs to the natural order *Cruciferæ*. The wild plant from which it sprang, the sea-cabbage (*Brassica oleracea*), grows upon the cliffs of the southern and western coasts of the British Isles. The term **colewort** is used as a general one to apply to all the plants of the genus. The final "wort" is the Saxon wyrt, a root, German wurz; while "cole" is the same as the Scotch "kale" or "kail," German "kohl," Saxon "caul." The ordinary white cabbage, savoy, Brussels sprouts, broccoli, cauliflower, and the red cabbage used for pickling, are all varieties of the original sea-cabbage—a small unimportant plant in comparison with its descendants. The cauliflower is the flower or inflorescence of the plant, developed by cultivation; Brussels sprouts are the buds which appear in the axils of the leaves, the angle between the leaf and the stem of the plant. The cabbage tribe is, as a rule, difficult of digestion, and in the bowels sulphuretted hydrogen is apt to be formed from the abundance of sulphur they contain, thus occasioning offensive flatulence. The German sauerkraut is made from sliced cabbage, sprinkled with salt, pressed in tubs or barrels, and allowed to ferment till it becomes sour.

Sea-kale (*Crambe maritima*) is a hardy sea-shore plant, now grown in gardens and brought to great perfection, in which state it is said to be delicate and easy of digestion. By keeping the light from it, as is done with celery, it is kept white and an acrid taste prevented from developing.

Spinach (*Spinacia oleracea*) belongs to the same order as the beet (*Goosefoot* or *Chenopodiaceæ*). It is a native of Western Asia, and was introduced to England in the sixteenth century. The mountain spinach, a native of Tartary cultivated in France, belongs to the same tribe. It is the leaves of the plant that are used after being boiled, and sometimes as a salad.

Lettuce (*Lactuca sativa*) belongs to the *Compositæ*. It is a hardy plant, one of the chief vegetables used as salad because of its crispness and the quantity of water it contains, which makes it cool and refreshing. Such vegetables should be kept in water till used, as they absorb the water, remaining juicy and crisp instead of becoming dry. **Lactucarium** or **lettuce-opium**, is a drug obtained from the juice expressed from the flowering herbs of the garden and wild lettuce, and thickened by gentle heat. It possesses some slightly soothing properties, and is very occasionally given to induce sleep.

The **Endive** (*Cichorium Endivia*) belongs to the same order as the lettuce. It is a native of Northern China. It is the blanched leaves that are used, but it has a bitter taste.

Celery (*Apium graveolens*) belongs to the *Umbelliferous* order, native to Britain, growing wild in sandy marshes, and called **smallage**. The taste and smell of the wild plant are coarse and rank. By cultivation, however, by a method introduced from India, it becomes tender and pleasant. It is supplied with abundance of water and earthed up just to the tops of the leaves. It is used as a flavouring agent for soups and also as a salad. It contains a minute quantity of an essential oil, to which its peculiar aromatic properties are due.

Water-cress is a cruciferous plant, of which there are many varieties. The water-cress is *Nasturtium officinale*, the common garden-cress is *Lepidium sativum*. The water-cress is native to Britain, and grows in rivulets or shallow streams or ditches. Its pungent flavour is due to an essential oil. The common cress is a native of the East. Belonging to the same order is **white mustard** (*Sinapis alba*), whose leaves are also used as a small salad.

Onion and **Asparagus** both belong to the Lily order. The former (*Allium Cepa*) is a native of the Levant. The same species includes the shalot, leek, garlic, and chive. All of these possess a very strong pungent taste and smell, due to a volatile oil, rich in sulphur, which they contain in minute quantity. This oil confers a marked stimulating and irritating property on the plants. **Asparagus** (*Asparagus officinalis*), called vulgarly sparrow-grass, is originally a wild sea-coast plant, but is now grown in gardens. The part used is the young shoot, which constant cultivation has made delicate and tender. From the shoots a crystalline substance, asparagin or althein, can be separated. It is also found in the potato, in belladonna, in liquorice and marsh-mallow roots. It is used in some forms of dropsy and gout.

Parsley is an umbelliferous plant, the common kind (*Petroselinum sativum*) is a native of Sardinia. An essential oil with the peculiar aroma of the plant can be separated from it.

Artichoke, to be distinguished from Jerusalem Artichoke, is of the order *Compositæ*. It is the green flower-head of the plant (*Cynara Scolymus*), native to Barbary and South Europe. Another plant of the same genus, the **cardoon** (*C. Carduncellus*) is used on the Continent. The parts used are the thick, fleshy stalk and leaf-ribs. They are blanched for use. It is a native of countries on the Mediterranean shore.

Many other plants, in whole or part, are used as salad, &c., such as borage, sorrel, rape, dandelion leaves, and many others.

Rhubarb, though usually called a fruit, that is, the portion that is used for tarts, is really the fleshy leaf-stems of the plant. It belongs to the same natural order as buckwheat, the *Polygonaceæ*. It comes from the river Volga, whence it was brought in 1573. The root of the Turkey rhubarb is used as medicine. *Rheum* is the name of the plant, the English rhubarb being *R. rhaponticum*, the medicinal kind being *R. officinale*. Formerly the leaves were boiled to yield a sauce used for meat. As a nutrient it is of little value, but its juice and mineral matter are valuable. The quantity of sugar it contains (2 per cent) enables a home-made wine to be manufactured from it.

FRUITS.

Average percentage Composition of Cucumber, Vegetable Marrow, and Tomato.

	Cucumber.	Vegetable Marrow.	Tomato.
Water	96·2	94·8	89·8
Nitrogenous	0·2	0·6	1·4
Carbohydrate (starch, sugar, &c.)	2·7	2·6	6·7
Fat	—	0·2	—
Fibre	0·5	1·3	1·3
Saline	0·4	0·5	0·8

These three fruits have been placed together because they are used rather as vegetables than as fruits in the ordinary sense of the word. They are, however, the fruits of their respective plants.

Cucumber belongs to the natural order *Cucurbitaceæ* (*Cucurbita*, Latin, a gourd), to which also belong the gourd, the pumpkin, the melon, and of medicinal plants the colocynth (bitter-apple or bitter-cucumber) and bryony. The common cucumber is the *Cucumis sativus;* it is native to the Levant, and was introduced into England in 1573. They flourish best in rich, open soil, need plenty of water, and are more juicy and digestible when grown quickly under glass. They are, however, in any form rather difficult of digestion, and are specially so when raw. The addition of vinegar, pepper, &c., aid digestion by stimulating the stomach. They are really of no nutritive value, consisting mainly of water, as the table shows; the only nutrient is 2 per cent of sugar. When young, cucumbers are pickled under the name of gherkins.

Vegetable Marrow is akin to the pumpkin and common gourd, belonging to the same order as they and cucumber. It is *Cucurbita ovifera.* The **Squash** is a variety of the same plant. It contains less water and more nutrient than cucumber. Of the 2·6 per cent of carbohydrate, 2 is sugar and ·6 starch. It is a wholesome adjunct to food.

Melon (*Cucumis Melo*) is a variety of the gourd. The water-melon (*Citrullus vulgaris*) is another variety.

Tomato (*Lycopersicum esculentum*, love-apple) belongs to the Nightshade order (*Solanaceæ*), as does the potato and tobacco. It is a native of South America. In Britain they grow best in hothouses. They are used in all sorts of ways, cooked in sauces, or raw, with the addition of pepper and salt, or in their natural fully ripe state without any adjunct. They have a very agreeable flavour, and are readily digestible. They contain ·7 per cent of a free acid—malic acid—the same as exists in the apple, pear, and plum.

Egg-apple (Fig. 202) (a variety of *Solanum esculentum*) is used for sauces, or boiled, and otherwise used as the tomato. It is the fruit of the plant to which the term egg-apple, aubergine, or brinjal is applied. "It is of an elongated form and purple colour. It is somewhat largely eaten on the Continent, and to some extent also in England; but it is dry and spongy, and devoid of the agreeable qualities belonging to the tomato. In America it is a favourite vegetable, and is there usually sliced and fried."

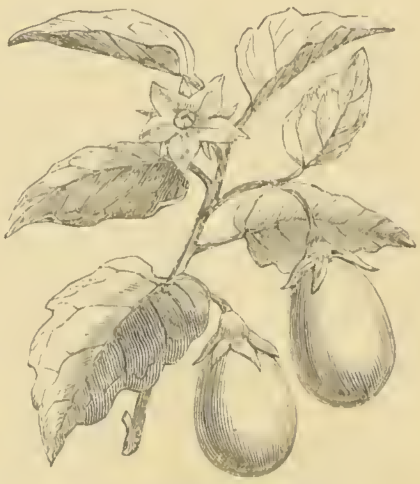

Fig. 202.—Egg-apple.

Average percentage Composition of Apples, Pears, Plums, Grapes, &c.

	Apples.	Pears.	Plums.	Damsons.	Peach.	Cherries.	Grapes.	Goose-berries.	Currants.	Straw-berries.	Oranges.
Water	83·0	84·0	81·8	81·2	85·0	80·3	80·0	86·0	84·8	87·7	89·0
Nitrogenous	0·4	0·3	0·4	0·8	0·5	0·6	0·7	0·4	0·5	1·1	0·7
Sugar	6·8	7·0	3·6	6·2	1·8	10·2	13·0	7·0	6·4	6·3	4·6
Other non-nitrogenous substances	5·2	4·6	4·7	4·9	8·0	1·2	3·1	1·9	0·9	0·5	1·0
Free acid	1·0[1]	0·1[1]	1·5[1]	0·8[1]	0·7[1]	0·9[1]	0·8[2]	1·5[3]	2·1[1]	0·9[4]	2·4[3]
Fibre	3·2	3·7	4·4	5·4	3·4	6·1	2·0	2·7	4·6	2·7	1·8
Saline	0·4	0·3	0·6	0·7	0·6	0·7	0·4	0·5	0·7	0·8	0·5

[1] Malic acid. [2] Tartaric acid. [3] Citric acid. [4] A mixture of citric and malic acids.

The fruits in the above list have all very much the same characters, so far as chemical composition is concerned. In all of them there is a very low proportion of nitrogenous constituent, but a considerable quantity of carbohydrates, especially sugar, and other non-nitrogenous substances such as gum and pectin, the jelly-like material obtainable from fruits. The quantity of sugar varies with the degree of ripeness. In the unripe condition starch rather than sugar is present, but by process of ripening the starch becomes transformed. At the same time much of the acid and astringent constituents of the unripe fruit disappears. It is during this process that the special flavour is developed, the transformation being the result of the absorption of oxygen, which is characteristic of ripening fruit. When the fruit is overripe, fermentive changes have set in, and changes of decomposition, by which the fleshy part of the fruit is broken down, and the seed which it shelters liberated. Besides, for the sugar, &c., which they contain, fruits are valuable for their free acid, which varies in different fruits, being malic, citric, tartaric, or a mixture of some of them (see foot-notes), and also for their saline ingredients. These vegetable acids and salts are specially serviceable when salted or preserved meats are largely used in the diet, as they supply ingredients that without them would be wanting, and whose absence would occasion a very unhealthy condition, scurvy being apt to arise. They are useful also in correcting the tendency to the accumulation of excessive quantity of acid in the body, especially uric acid, of which gout, and probably to some extent also rheumatism are manifestations. Taken freely, these substances diminish the acidity of the urine, and, if taken in larger quantities, render it alkaline. A diet rich in animal food is apt to occasion unsatisfactory states of general health, because of the excessive storing of acid in the system. There is little doubt that the advantage experienced by many from a more free use of fruits than is customary is due to their power to diminish this acidity. Some forms of headache, especially the sick or nervous headache, megrim, are supposed to be partly caused by such excessive accumulation of acid in the system. It would be worth while for those, subject to complaints of this kind, to try the effect of free use of such fruits as oranges, lemons, and tomatoes.

Apples, Pears, Quinces, and **Medlars** all belong to the sub-order *Pomeæ* of the natural order of the rose (*Rosaceæ*). The apple-tree is called *Pyrus Malus;* the pear is *Pyrus communis.* The varieties of cultivated apples have sprung from the wild, or crab-apple of the hedges, a native of Great Britain. It grows in all temperate climates. Normandy pippins, or "biffins," are apples dried and flattened. **Cider** is the fermented juice of apples, **verjuice** of the crab-apple, and **perry** of the pear. Apples seem not to be so difficult of digestion, when raw, as is generally supposed, if they are well chewed. Stewed or roasted, they are still more easy of digestion. They are useful in persons troubled with habitual costiveness of bowels.

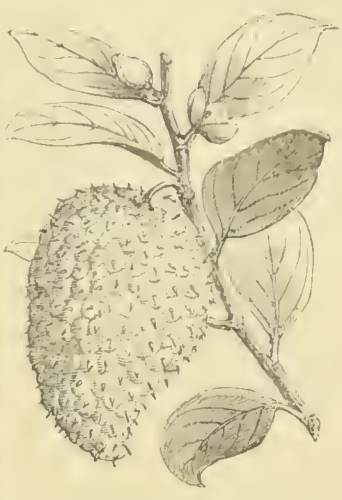

Fig. 203.—Sour-sop or Anona (*Anona muricata*).

The term apple is applied to other fruits of quite different kinds. Thus the **custard-apple** is the fruit of the *Anona reticulata*, of the same tribe as the sour-sop of the West and East Indies. (See fig. 203.) The **egg-apple** belongs to the same order as the tomato, and is used as a vegetable (see p. 574).

The **Quince** is the fruit of *Pyrus Cydonia*, or *Cydonia vulgaris.* It is supposed to be a native of Western Asia. The fruit is golden yellow. In temperate climates, because of its want of ripening, it is used cooked in sugar, or made into marmalade. The Bengal Quince, *Ægle Marmelos,* golden apple, or bael fruit belongs to the orange order.

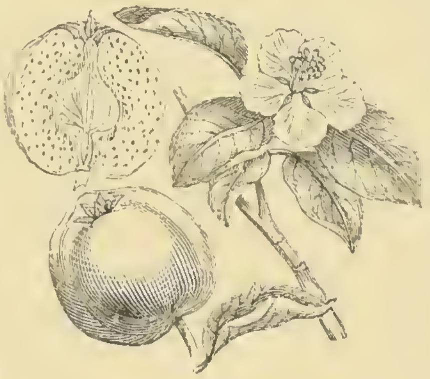

Fig. 204.—Quince (*Cydonia vulgaris*).

The **Medlar** is the fruit of the tree *Mespilus germanica*, which grows wild in several parts of Central Europe and in Britain. The pulp is very tough, but becomes soft when decay has set in, in which condition the flavour is deemed best.

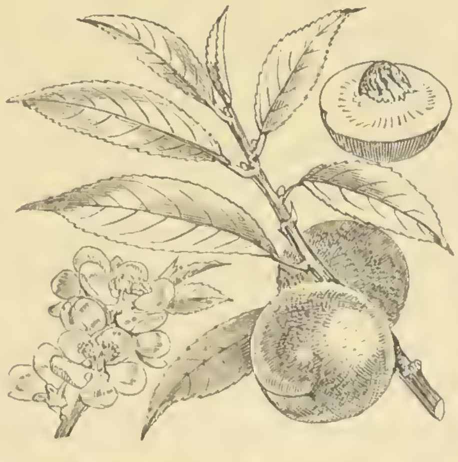

Fig. 205.—Peach (*Amygdalus persica*).

Plums, Damsons, Apricots, Peaches, and **Cherries** all belong to the *drupaceous* or stoned-fruit class of the Rose order. The common plum is *Prunus domestica*, which is a native of Asia Minor. There are various species belonging to different temperate climates. The damson is a plum originally derived from Damascus, and the green-gage is another variety. **Apricots** are the fruit of *Prunus armeniaca.* **Cherries** are the fruit of *P. Cerasus.* Their richness in sugar is a notable feature. **Kirschwasser** is a liqueur obtained from them. **Maraschino** is another liqueur prepared from a more delicately-flavoured kind. Prunes, or French plums, are dried plums, the finest being called by the latter name. The **peach** belongs to the genus *Amygdalus*, the *A. persica*, the almond group of *Rosaeeæ.* The composition given in the table does not include the stones. It will be seen that their nutritive value is insignificant. **Nectarines** are a variety of the same tree.

Grapes. The grape is the fruit of *Vitis vinifera*, of the natural order *Vitaceæ*, native to the East, about the region south of the Caspian. There are a great many varieties. Raisins are the dried fruit, and currants are small varieties. **Sultanas** are raisins without stones; **muscatels** are the finest sort, dried in the sun on the branch, after the stalk is partially cut through. The large percentage of sugar contained in grapes gives them a pre-eminence as regards nutritive quality above every other fruit of the berry kind. Raisins contain 45 per cent less water than grapes, a total of only 32 per cent, and they contain no less than 55 per cent of sugar, so that they are highly nourishing, though the nitrogenous element amounts to only 2·4 per cent. The value of associating almonds and raisins is seen from the fact that the former contains 24 per cent of nitrogenous material and nearly 54 per cent of fat, they are, that is to say, very rich in exactly the ingredients in which raisins are deficient. The acid of the grape is chiefly tartaric, and it is usually combined with potash to form tartrate of potash.

"I think we may assert," says Dr. Cullen, "that grapes, which contain a large quantity of sugar, are, if taken without their husks, the safest and most nutritive of summer fruits." "In the inflammatory form of dyspepsia, and in pulmonary affections, ripe grapes are eaten, in considerable quantities, in Switzerland and other parts of the Continent, occasionally with considerable benefit, and forming what is called the 'cure de Raisins'" (Pereira). They act both upon the bowels and kidneys, gently stimulating the action of both, specially if taken in the morning on an empty stomach.

Strawberries are natives of temperate climates, and are found in Europe, America, and Asia. They belong to the Rose order, to the genus *Fragaria*, the common strawberry being *F. vesca.* The English strawberry has reached its present condition as the result of cultivation. They are not rich in nutritive material, but if eaten alone, or only with sugar, they are digested with comparative ease.

Currants and **Gooseberries** belong to the tribe *Grossulaceæ*, of the natural order *Saxifragaceæ.* The currant plant is *Ribes*, the red currant being *R. rubrum*, and the black *R. nigrum*, while the gooseberry is *R. grossularia.* The latter is native to many parts of Europe and Northern Asia. The currants are also natives of Europe and Asia and some parts of North America. Both currants and gooseberries are alike in alimentary properties, which are of little consequence. These currants are to be distinguished from the dried currants, which are small black dried grapes.

Raspberries and **Blackberries** (brambles) belong to the sub-order *Roseæ* of the natural order *Rosaceæ.* The former (*Rubus idæus*) is a native of Britain; the latter (*Rubus fruticosus*) is also indigenous in Britain and Europe generally. It is a hedge bramble. The **Dewberry,** or grey bramble (*R. cæsius*), does not grow in hedges but on the ground.

Bilberries or **blaeberries** (Fig. 206) (*Vaccinium myrtillus*), **bog whortleberry** (*V. uliginosum*), **red whortleberry** or **cowberry** (*V. vitis idæa*), **marsh whortleberry** or **cranberry** (*V. oxycoccus*), all belong to the natural order *Vacciniaceæ.* They are found in Britain, Europe, and America. They are all very much alike in chemical composition.

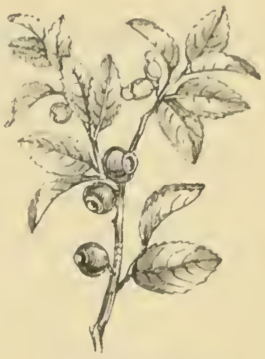

Fig. 206.—Bilberry.

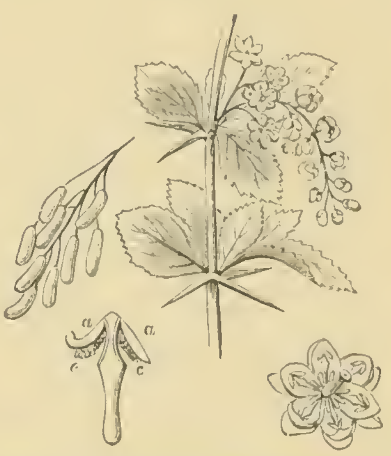

Fig. 207.—Barberry (*Berberis vulgaris*).

Barberry (Fig. 207) (*Berberis vulgaris*) belongs to the order *Berberidaceæ.* It is very acid and astringent, found in Europe, Asia, and America, in hedges. Pepperidge or peprage bush is an old name in England for the plant. The berries are oval in form, and generally bright red. A mordant for dyers is made from the bark.

Elder-berries are the fruit of *Sambucus nigra*, small trees or shrubs of the natural order *Caprifoliaceæ*. The honeysuckle and viburnum belong to the same order. It is native to Europe and the north of Asia and Africa. The branches of the tree contain an unusually large amount of pith, which is easily removed, so that tubes are readily formed. Hence the name bore-tree, and in Scotland bour-tree. Elderberry wine is a highly-flavoured wine made from the berries, which are black in colour and faintly acid to taste. Elder-rob is the juice obtained by pressing the berries.

Mulberries (Fig. 208) are the fruit of the *Morus nigra*, of the order *Urticaceæ*, or *Moraceæ*, the same order to which fig belongs. It is a native of Persia, but is extensively grown in Europe. The fruit is purplish-black, more than usually acid, and with a fine flavour. It is cooling and slightly laxative.

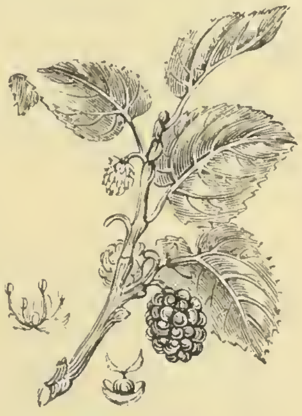
Fig. 208.—Black Mulberry (*Morus nigra*).

Oranges are the fruit of the *Citrus*, belonging to the natural order *Aurantiaceæ*. The sweet orange is *C. Aurantium* (Fig. 209). It is supposed to be native to India and China, but has long been grown in Egypt, Italy, Spain, and other parts of Southern Europe. It is in perfection only when gathered ripe from the tree. The imported oranges are all pulled while yet unripe. The nutrients it contains are too small in quantity to make the fruit valuable from that point of view, but the acid it contains, and the salts, and the essential oil of the rind, confer upon the fruit a very high value, and make them exceedingly valuable and wholesome food adjuncts. When quite ripe it may be partaken of in almost any state of health, the pulp being, of course, rejected after the juice has been sucked out. The acid is citric acid, and it is united in the fruit with potash, chiefly as citrate of potash. There are several varieties of the orange. The bitter or Seville orange is *C. vulgaris*. The rind is rich in flavouring oil, and is largely used for flavouring, and for the extraction of tincture, to be employed as an aromatic tonic. The flavour of the liqueur curaçoa is due to the bitter orange. From the flower of this variety, also, the finest orange-flower water is distilled. From orange-flowers another oil is obtained—the oil of neroli. The mandarin orange is a variety of the sweet orange. So also is the Malta orange with its blood-red flesh. The **Citron** (*C. Medica*) is a different species. The **Lime** (*C. acida*) is native to the East, and is grown in the West Indies and south of Europe. It is smaller than the lemon. Its juice is very acid, and is extensively used as a preventive of scurvy. The **Sweet Lime** (*C. Limetta*) is a variety.

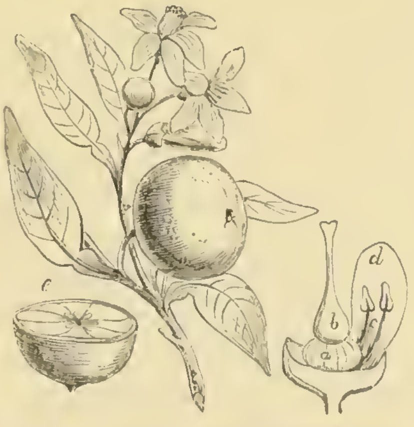

Fig. 209.—Orange (*Citrus Aurantium*). *a*, Ovary. *b*, Style. *c*, Stamens. *d*, Petal. *e*, Section of fruit.

The **Lemon** (*C. Limonum*) is a native of the north of India, but is grown also in Southern Europe. The juice is more acid than that of orange, and is very extensively used for a refreshing beverage, the essential oil from the rind being also a popular flavouring agent.

The **Shaddock** (*C. decumana*) and the **Pomelo** or **Pompelo** (*C. Pompelmoos*) very much resemble one another and the orange. The latter is the fruit sometimes called "the forbidden fruit."

The **Cumquat** (*C. japonica*) is another species of *Citrus*. All these varieties have the same general characteristics of juicy acid fruits and aromatic oils in the rind.

The **Pomegranate** (Fig. 210), fruit of the *Punica granatum*, is not unlike the orange. The pulp is reddish, slightly acid. The rind is very astringent, and is used sometimes on this account. The root has the same action, and is used in medicine; the dried root is used for yielding an astringent decoction. The *Punica granatum*, however, does not belong to the same order as the orange, but to the order *Myrtaceæ*, to which cloves, all-spice, cajeput, and the blue-gum tree belong. **Guava** (*Psidium pyriferum*) also belongs to the same order as pomegranate. It yields the well-known West Indian preserve, guava-jelly. Guava preserves are also

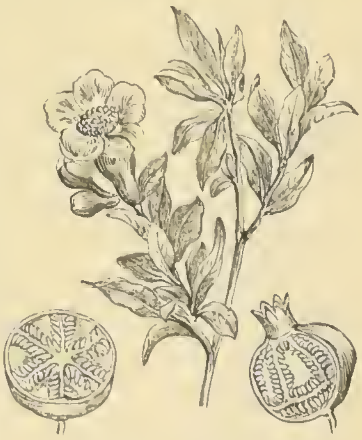
Fig. 210.—Pomegranate (*Punica granatum*).

largely made at the Cape Colony. It is a roundish fruit, larger than a hen's egg, with smooth yellow rind, and firm flesh-coloured pulp, filled with hard seeds, of sweetish aromatic taste. There are several varieties of it—red guava and China guava, which are more acidulous to taste than the common or white variety.

Average Percentage Composition of Figs, Dates, and Bananas and Bread-fruit.

	Dried Turkey Figs.	Dates (stoned).	Bananas (peeled).	Bread-fruit.
Water	17·5	20·8	73·9	63
Nitrogenous	6·1	6·6	4·8	3
Carbohydrate (starch, sugar, &c.)	65·9	65·3	19·7	14
Fat	0·9	0·2	0·6	20
Fibre	7·3	5·5	0·2	
Saline	2·3	1·6	0·8	

These fruits occupy a very different position from those of the preceding table, dependent upon their great alimentary value. Rich in starch or sugar, and with a proportion of albumin and a very small percentage of fat they are, each of them, capable without further addition, except that of water, of sustaining life for prolonged periods. Though generally regarded simply as pleasant fruits, in the ordinary meaning of that word, they form in some parts of the East the main food of the people for certain seasons.

Figs are the fruit of the *Ficus carica* (Fig. 211), belonging to the natural order *Moraceæ*, to which the mulberry and banyan belong, and to which the india-rubber tree (*F. elastica*) of commerce belongs. It is grown in warm climates, native to the East and naturalized in Southern Europe, attaining its perfection along the Mediterranean shores, and in Turkey. The fig as eaten is really a hollow fleshy receptacle for the fruits, which are concealed within it. In the ripe state the so-called seeds are the actual fruits, the ripe carpels or seed-vessels of the flowers. Of the fig there are numerous varieties, differing in size, colour, &c. The **sycamore** (*Ficus sycomorus*, Fig. 212) is a species of fig. Its fruit is also eaten and is sweet and delicate; it is smaller than the ordinary fig.

Fig. 211.—Fig (*Ficus carica*).

Fig. 212.—Sycamore (*Ficus sycomorus*).

The table shows the composition of the finest dried figs. The carbohydrate is mainly sugar, to the extent of 57½ of the 65·9 per cent. By referring to p. 562 it will be seen that they contain almost as much nitrogenous material as fine white bread, and over 13 per cent more carbohydrate and more fat. One may, therefore, say they contain more nutriment than bread, but the so-called seeds are liable to cause irritation of the bowel if they are eaten in large quantity. One of the finest figs steeped over night in a quantity of water such that it can absorb, and eaten in the morning on rising, is a gentle aid to relaxation of the bowels.

The **Banyan** (*Ficus indica*) belongs to the same order as the fig, and produces edible fruit of the size of a cherry. It is a tree remarkable for size, owing to its manner of growth. The branches send down shoots which take root and grow into trunks, and thus the tree spreads till it covers a large area. A famous tree on the banks of the Nerbudda has 350 such stems, each of the size of an ordinary trunk, and 3000 smaller ones. It can shelter beneath it 7000 men (Fig. 213).

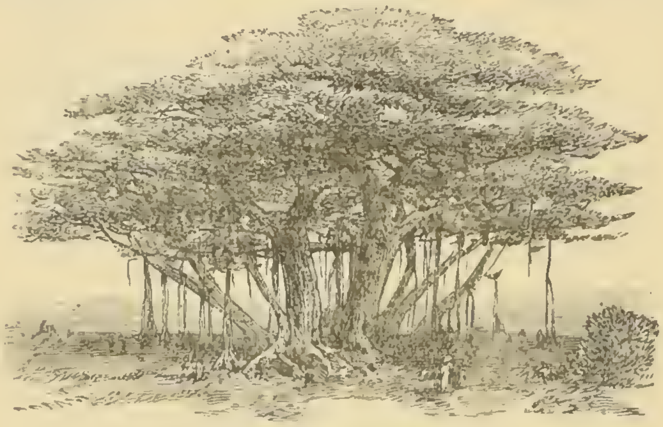

Fig. 213.—Banyan Tree.

Indian-fig or **Prickly-pear** (Fig. 214) (*Opuntia vulgaris*) does not belong to the fig or pear order, but to the Cactus order (*Cactaceæ*). It is a native of America, and is grown in Southern Europe and North Africa. The fruit resembles a fig of a deep rose colour, larger than a hen's egg, with juicy and sweetish acid pulp.

Fig. 214.—Prickly-pear.

Dates are the fruit of the date-palm (Fig. 215)—the palm-tree of Scripture (*Phœnix dacty-*

lifera). It is a native of the north of Africa and parts of Asia, and has been brought to Southern Europe. Its stem passes straight up without branch or interruption to a height of 50 or 60 feet, and then throws out a crown of feather-shaped leaves. The fruit is in bunches of 180 to 200 dates, each bunch weighing 20 to 25 pounds. The fruit is eaten in the fresh ripe state, or dried, and also pounded or pressed into a kind of cake, for the use of travellers through the desert, and the inhabitants of Northern Africa. The table shows the composition of the date as imported and after being stoned. In this condition it is in chemical composition much like the fig. The date-palm "is invaluable amid parched sands and arid deserts. Wherever a spring of water appears amid the sandy deserts of Africa, this graceful palm yields at once both its grateful shelter and its nourishing fruit. Where all other crops fail from drought the date-tree still flourishes. In Egypt and Arabia it forms a large portion of the general food, and among the oases of Fezzan 'nineteen-twentieths of the population live upon it for nine months of the year'" (Johnston).

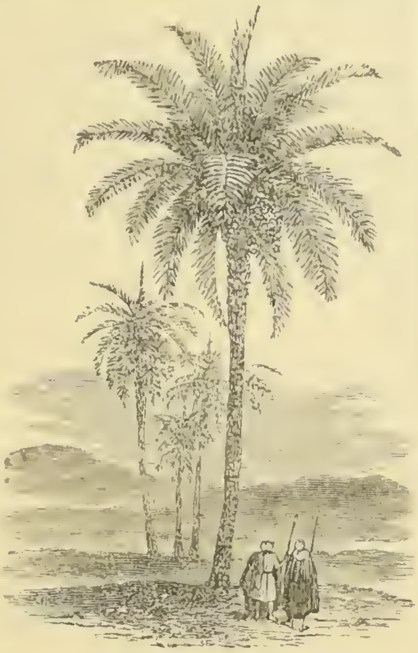
Fig. 215.—Date-palm (*Phœnix dactylifera*).

Banana is the fruit of a favourite tropical tree (*Musa sapientum*, Fig. 216) of the natural order *Musaceæ*. The leaves are 6 feet long by 1 broad, and are used for thatching, basket-making, &c., while the quantity of fibrous tissue in the stalks makes them useful for the production of flax. Manilla hemp is yielded by a tree of the same order (*M. textilis*). The fruit grows in bunches of from 100 to 200, weighing 40 to 80 pounds. Its main constituent is, in the unripe state, starch, which in process of ripening becomes converted into sugar. Of very luscious taste it is a wholesome and nutritious food. The tree yields, for the same extent of ground covered, more food than any other vegetable. According to Humboldt 1000 square feet of ground will yield of potatoes 462 pounds, of wheat 38 pounds, and of bananas 4000 pounds, and in a shorter period of time. "About 6½ pounds of the fruit, or 2 pounds of the dry meal, with ¼ pound of salt meat or fish, form, in tropical America, the daily allowance for a labourer, whether slave or free." The unripe fruit keeps better than the ripe, because of the carbohydrate being yet starch, and when dried in this state forms a kind of bread. Meal is prepared by pounding and sifting the dried fruit.

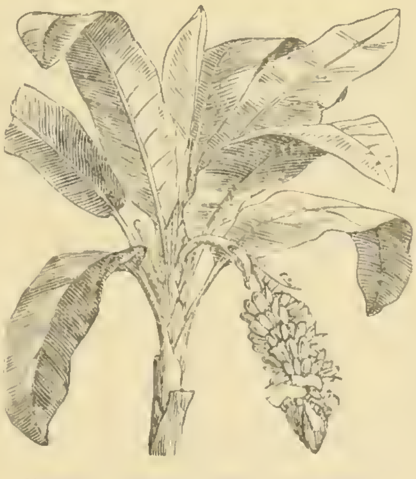
Fig. 216.—Banana (*Musa sapientum*).

The **Plantain** (Fig. 217, *Musa paradisiaca*), a variety of the same plant as the banana, yields a fruit almost identical with it, and equally useful. In British Guiana the meal, obtained by drying and pounding the fruit, is largely used for children and invalids.

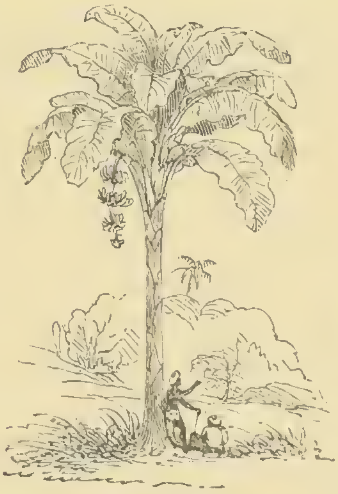
Fig. 217.—Plantain-tree (*Musa paradisiaca*).

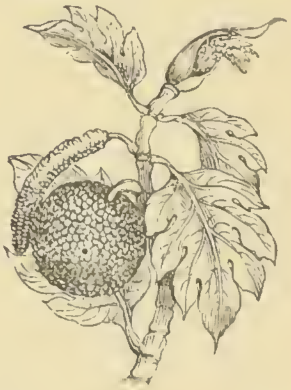
Fig. 218.—Bread-fruit (*Artocarpus incisa*).

Bread-fruit (Fig. 218) is obtained from a tree (*Artocarpus incisa*) found in the islands of the Pacific, specially in the Friendly and Marquesas Islands. The fruit is round and about the size of a child's head, being formed of the female flowers united into a fleshy mass. Several crops appear in succession, the tree flowering for eight or nine months continuously. Like the banana its chief ingredient is carbohydrate, which becomes sugar when the fruit is fully ripe, but is in the form of starch when unripe. Raw, the fruit is insipid in taste, and it is, therefore, usually plucked before being ripe; the rind is removed and the white pith is wrapped in leaves and baked on hot stones. "In this state it tastes like white wheaten bread, sometimes rather sweeter." During the months when the tree is not bearing, the unripe fruit is used in a preserved state. The preservation is effected in paved pits covered with leaves and stones, where the fruit becomes sourish and forms a kind of paste, of which a piece is baked on stones as required. In this form it is said to taste like black Westphalian bread when not thoroughly baked. These trees, it is said, will yield fruit sufficient to sustain one man for eight months. "Whoever has planted ten bread-fruit trees has fulfilled his duty to his own and succeeding generations as completely and amply as an inhabitant of our rude clime, who, throughout his whole life, has ploughed during the rigour of winter, reaped in the heat of summer, and not only provided his present household with bread, but painfully saved some money for his children" (Captain Cook).

A variety of the bread-bruit is **Jack-fruit**, yielded by the *Artocarpus integrifolia.* The tree is grown in Southern India and in Asia, and the fruit is much used in Ceylon. It is coarser than the bread-fruit.

NUTS.

Average percentage Composition of Nuts.

	Almonds.	Filberts.	Walnuts.	Cocoa-nuts.	Pea-nuts or ground-nuts.	Chestnuts.
Water	5·4	4·1	4·7	46·6	7·5	51·5
Nitrogenous	24·2	15·6	16·4	5·5	24·5	5·5
Starch, gum, &c	7·2	9·0	7·9	8·1	11·7	38·3
Fat	53·7	66·1	62·9	35·9	50·0	1·4
Fibre	6·5	3·3	6·1	2·9	4·5	1·6
Saline	3·0	1·9	2·0	1·0	1·8	1·7

The prevailing characteristic of nuts is well shown in the above table. They are all rich in oil, exceptionally rich indeed, with the exception of the chestnut. The proportion of oil, scarcely below 50 per cent in any, gives them a very high alimentary value. At the same time they are also rich in albuminoid material, on an average as rich in that ingredient as flesh meat. They contain comparatively little starch. In fact the starch of the cereals is in the nuts replaced by oil. Although thus a very nourishing food they are rather difficult of digestion, unless when ground and mixed with some lighter kind of food, which will keep the nut in a finely-divided state. The fat is apt under exposure to become somewhat rancid. The chestnut is quite an exception to these general rules. It is a farinaceous seed, the starch taking the place of oil in quantity, and it is much less rich in nitrogenous material, resembling, therefore, the cereals.

Almond is the seed of the *Amygdalus communis* (Fig. 219), belonging to the natural order *Rosaceæ.* It belongs to the East, and is extensively cultivated in the south of Europe. The bitter almond (*A. amara*) is a variety of the former. The sweet almonds imported from Malaga, and called Jordan almonds, are the finest. By pressure the oil may be separated from the nut, the ordinary almond-oil of commerce, consisting chiefly of olein, which is bland, harmless, and odourless. From bitter almonds, by distillation, a volatile oil may be separated, which is of a different character. As sold in the shops it contains prussic acid, and is highly poisonous. This poisonous property is due to the presence of hydrocyanic or prussic acid, which, however, does not exist in the seed as such, but is produced as a result of a fermentation set up when the seed is moistened. This fermentation is due to the action of two substances contained in the seed, emulsin, an albuminous substance, and amygdalin, a crystalline nitrogenous substance. The result of the interaction of these two substances is the production of the volatile oil (essential oil of bitter almonds), prussic acid, and other substances. The prussic acid may be driven off from the oil by heat, and then the oil is harmless. But this is not usually done, and the oil retains its poisonous character. This fermentive change may occur in the mouth on chewing the bitter almond, and risk consequently attends their being eaten. Pereira says "the smaller animals, as dogs, pigeons, &c., are readily destroyed by them. One drachm (60 grains) has killed a pigeon, and twenty seeds have destroyed a dog. . . . . Macaroons

Fig. 219.—Almond (*Amygdalus communis*).

and ratafia cakes, as well as noyau, which owe their peculiar flavour to these seeds, likewise prove injurious when taken in large quantities." The essence of bitter almonds, sold for flavouring purposes, is the essential oil diluted with spirit. It should not be freely employed.

Sweet almonds are apt to occasion very considerable digestive disturbance, if eaten without the skin being removed, that is unblanched. Almonds thus eaten have been known to produce sickness, swelling of the face, and nettle-rash. The favourite sweetmeat marzipan is a sweetened almond paste.

Filbert Nuts, Hazel-nuts, and **Cob-nuts** are all produced from varieties of the same plant, *Corylus,* natural order *Corylaceæ*, to which the oak, beech, and sweet chestnut belong. **Hazel-nuts** are derived from *C. avellana*, which grows wild in Great Britain; the best come from Spain, and are called Barcelona nuts. The **filbert** (*Corylus tubulosa*) is a carefully-cultivated variety, and to it the remarks made at the beginning of these paragraphs fully apply.

Walnuts are the seeds of a tree, *Juglans regia* (Fig. 220), of the order *Juglandaceæ*. It is a tall spreading tree, a native of Persia, and was introduced into Greece and Italy some centuries before the Christian era. A sweet oil, used for food and, under the name of nut-oil, as a drying oil for painting, may be expressed from them. Unripe, they are used for pickling and making ketchup. The **butter-nut** from *Juglans cincrea*, and the black walnut are varieties much cultivated in America. The hickory tree (*Carya alba*) yields a nut, the **hickory-nut**, and belongs to the same natural order. A variety of it, *Carya olivæformis*, yields the **pecan-nut**. These are all North American trees.

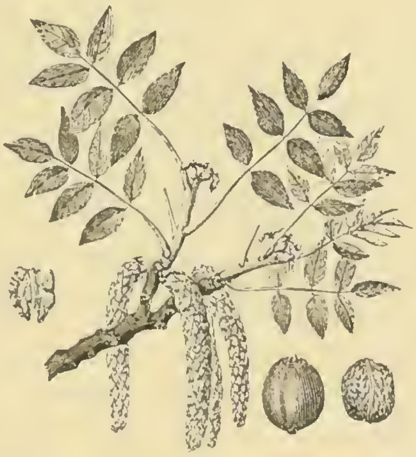

Fig. 220.—Walnut-tree (*Juglans regia*).

Cocoa-nut is the fruit of a palm, Fig. 221 (*Cocos nucifera*), belonging to the natural order *Palmaceæ*. The name is said to be derived from *coco*, meaning a distorted mask, the name given to the nut by the Portuguese in India, because of the markings at the base of the nut suggesting a monkey face. The tree is grown extensively in the tropics. The fruit is in bunches of 12 to 20, and a single tree will bear from 80 to 100 nuts. Every part of the tree is useful. A thick fibrous husk surrounds the shell, of which matting is made, as well as a yarn called **coir**, of which cordage may be made; the shell itself is used for bottles and drinking-cups, and if burnt yields valuable charcoal. From the flowering branch is obtained a sweet juice, which, when allowed to ferment, is called **toddy** or **palm-wine**, and from this the spirit called **arrack** is distilled. The table shows the richness of the nut in oil, which may be separated out by pressure. The edible portion is somewhat fibrous and indigestible. The nut, however, is the chief food of the inhabitants of Ceylon, the South Sea Islands, and other tropical regions. The milk of the cocoa-nut is pleasant and cooling, and has the following composition:—

Water	91·5
Nitrogenous	·46
Fat	·07
Sugar, &c.	6·78
Saline	1·19

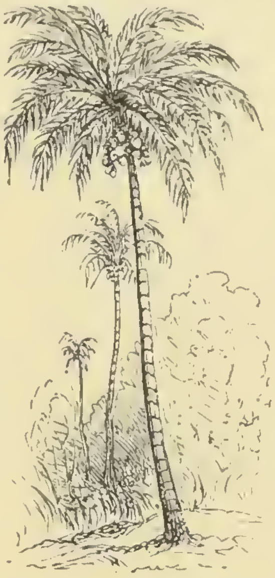

Fig. 221.—Cocoa-nut Palm (*Cocos nucifera*).

The Ground-nut or **Pea-nut** (Fig. 222) is the fruit of a leguminous plant, the *Arachis hypogæa*, common to the warm parts of America. It is also cultivated along the West Coast of Africa. It flowers not unlike the pea. The seeds are in pods, borne on long stalks, which, after flowering is past, curl towards the ground, so that the pods become buried in the earth, where they come to maturity. They contain 50 per cent of oil, and when this has been removed by pressure, the cake that is left, rich in albuminous material and starch, is used for feeding cattle.

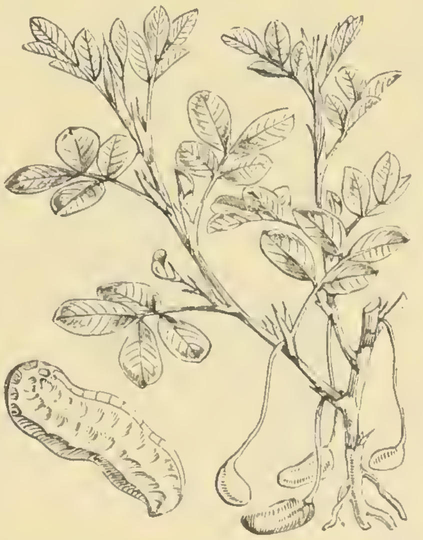

Fig. 222.—Ground-nut (*Arachis hypogæa*).

Pistachio-nuts, the fruit of a small tree, the *Pistacia vera* (Fig. 223), is native to Western

Asia, but cultivated along the Mediterranean coasts. To the same order belong the sumach, mango, and cashew. Mastic is the product of one of the pistacias (*P. lentiscus*). The fruit is like a small almond, and has a similar taste. The kernel contains chlorophyll, which gives it a green colour. It is sometimes called the green almond. They are used for confectionery and dessert. Their composition is almost identical with that of the ground-nut (see table).

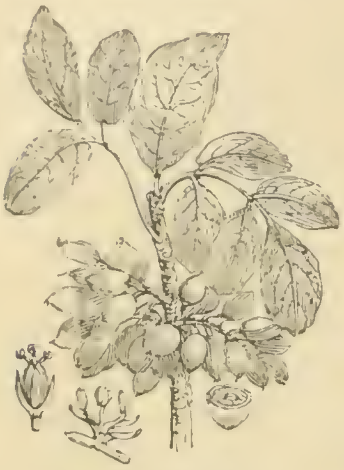
Fig. 223.—Pistacia vera.

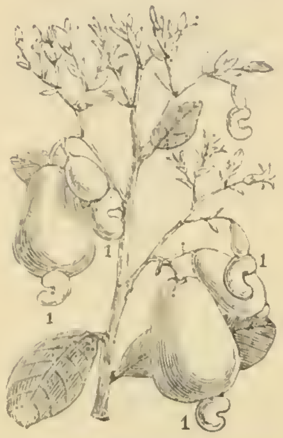

Fig. 224.—Anacardium occidentale. 1 1 1, Cashew-nuts.

Cashew-nuts or **Acajou-nuts** (Fig. 224) are the fruit of the *Anacardium occidentale*, of the same order as the pistacia. It is a native of the West Indies. The nut is kidney-shaped, and about an inch long. The shell is very hard, and between its outer and inner layer there is a black acrid juice, which is driven off in very acrid fumes when the shell is roasted. The kernel contains a pleasant, wholesome oil, and is a common article of food in the tropics. The stalk of the fruit is large and fleshy, and may be eaten.

Brazil-nuts are the seeds of the juvia tree, *Bertholletia excelsa* (Fig. 225), belonging to the order *Lecythidaceæ*, which grow in abundance in Guiana, Venezuela, and in Brazil. The fruit consists of an outer hard shell, about ½ inch thick and 6 inches in diameter. Within it there are four compartments, each containing six or eight triangular nuts very closely packed. The kernel is rich in oil.

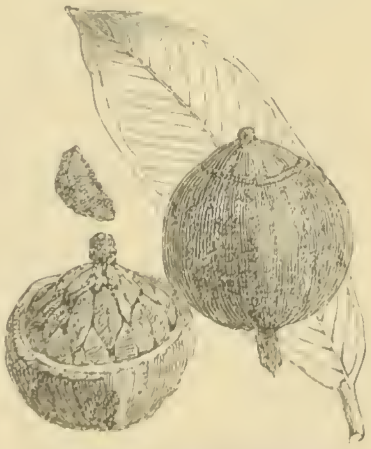
Fig. 225.—Fruit of *Bertholletia excelsa*.

Chilian Pine or **Puzzle-monkey** is a pine whose seeds are much used for food. The tree, *Araucaria imbricata*, is one of the *Coniferæ*, found in South America, Australia, and Pacific Islands. It is a favourite lawn tree in Britain. In Chili and Patagonia its seeds are used for food, and it is said "the fruit of one large tree will maintain eighteen persons for a year."

Dika Bread is made from the fruit of the *Irvingia Barteri* or *wild mango*, though it is not related to the Indian mango. It belongs to the order *Simarubaceæ*, to which quassia belongs. The tree grows on the West Coast of Africa. The fruit "is about the size of a swan's egg. It contains a large white almond-shaped kernel. The bruised kernels, warmed and pressed, form the so-called dika bread, which is largely consumed by the natives of the Gaboon, who use it when scraped or grated in stews" (Church). It consists to the extent nearly of three-fourths of fat, as the following note of its composition shows:—

Water	5·0	
Nitrogenous	9·5	
Starch	7·2	
Fat	73·0	
Fibre	3·0	
Saline	2·3	(Church).

Chestnut.—The Spanish or sweet chestnut is the produce of a stately tree, the *Castanea vesca*, which is a native of Western Asia, and is largely cultivated in Southern Europe and in North America. It belongs to the natural order *Corylaceæ*, also called *Cupuliferæ*, to which also the oak, beech, and hazel belong. It is eaten raw or roasted; it is also ground into flour and made into bread, which is readily done, because of the large quantity of starch it contains and the minute quantity of fat. It is an important article of food in Southern Europe, of agreeable flavour, but somewhat difficult of digestion.

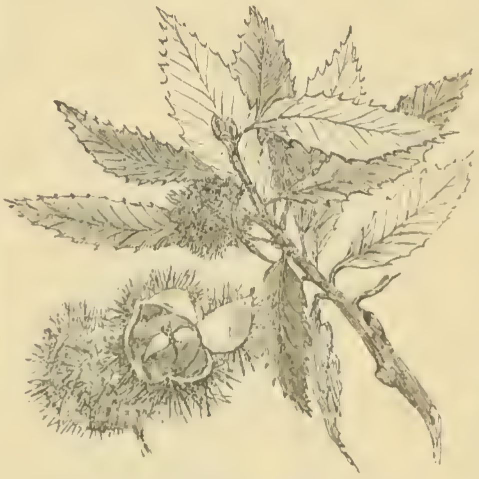
Fig. 226.—Chestnut (*Castanea vesca*).

FUNGI.

Average percentage Composition of Mushrooms, &c.

	Mush-room.	Morel.	Truffles. White.	Truffles. Black.
Water	90·0	90·0	72·4	72·0
Nitrogenous	5·0	4·4	9·9	8·8
Carbohydrates	3·8	3·7	15·2	16·6
Fat	0·7	0·6	0·4	0·6
Saline	0·5	1·3	2·1	2·0

Fungi are plants of a simple type of organization. They contain no chlorophyll, that is the green colouring matter of plants. They possess a considerable quantity of nitrogenous material, and are, therefore, of considerable alimentary value, but they are used mainly as flavouring and seasoning agents and for the production of sauces.

Mushroom.—There are many varieties of mushroom, some of them suitable for eating, many of them poisonous. It is said, also, that under circumstances of situation a mushroom, usually employed for food, may become hurtful. The species commonly used is the *Agaricus campestris*, or field mushroom. It is found growing in the open field in August and the two following months. It may be cultivated in gardens all the year round. They are eaten raw, boiled, baked, stewed or pickled, and when salted and pressed they yield ketchup. The mushroom consists of a net-work of thread-like material, the mycelium, growing underground. From this the stalk springs, bearing the head or cap or pileus of the mushroom. This is often of a sort of umbrella shape, and upon its under surface is a series of gills or bars, which bear the spores or seed of the fungus.

It is difficult to distinguish between good and poisonous mushrooms. As a rule, those suitable for food are white or brownish; the gaudily coloured are poisonous. The suitable kinds are found growing in the open fields, not in damp, shady places. Bentley gives the characters as follows:—

Mushrooms suitable for eating:	*Poisonous mushrooms:*
1. Grow solitarily in dry airy places.	1. Grow in clusters in woods, and damp, dark places.
2. Are generally white or brownish.	2. Are usually of a bright colour.
3. Have a compact brittle flesh.	3. Have a tough, soft, or watery flesh.
4. When cut do not change colour by the action of the air.	4. Acquire a blue, green, or brown tint when cut and exposed to the air.
5. Have a watery juice.	5. The juice is often milky.
6. Their odour is agreeable.	6. The odour is commonly powerful and disagreeable.
7. Their taste is neither bitter, acrid, salt, nor astringent.	7. Their taste is bitter, acrid, salt, or astringent.

Dr. Christison places reliance on the astringent styptic taste and disagreeable pungent odour as indicating certainly a poisonous fungus, though some poisonous kinds are devoid of any unpleasant smell.

The symptoms of poisoning from mushrooms are those of marked irritation of stomach and bowels, along with symptoms of brain disturbance. Thus there is colicky pain in stomach and bowels, sickness and purging, faintness and giddiness, dimness of sight, drowsiness, prostration and stupor. Sometimes the symptoms refer mainly to the stomach and bowels, and in other cases the symptoms are more those of a narcotic poison. They may arise very soon after the meal or not for some hours. If vomiting takes place soon, recovery is almost certain. To induce vomiting should be the first effort of treatment, a tea-spoonful of mustard in a tumblerful of hot water being a suitable means, tickling the throat with a feather, passing the finger down the throat, &c.

The poisonous active principle of one form of fungus—the fly fungus or fly amanita (*Amanita muscaria*, see Plate X.)—called muscarin, has been obtained from this fungus, which completely paralyses the heart of a frog, when it is touched with a drop of the solution. There is an antidote to this poison, namely belladonna (deadly nightshade) or its active principle atropina. Of tincture of belladonna 5–15 drops might be given every two or three hours while danger lasted, or, if the liquor atropiæ is to be had, a drop may be given in water every two or three hours. *Note* that belladonna may be given to children without fear. They are less susceptible to its use than adults.

The fungus containing muscarin is said to produce symptoms of intoxication, and symptoms of narcotic poisoning rather than of bowel irritation. Digitalis is also recommended as an antidote. Of its tincture 10 to 20 drops in water may be given repeatedly to an adult, 2 or 3 drops to a child.

The Morel (*Morchella esculenta*) grows in Britain, but is largely imported from Germany in a dry state. It is used for gravies.

Truffles (*Tuber cibarium*) are underground fungi, not growing at all above the surface. They are of a fleshy structure, dark in colour, covered with nodules, varying in size from a plum to a potato. They are found in Wiltshire, Hampshire and Kent in England, especially in oak and chestnut forests. Dogs are trained to unearth them, guided by the sense of smell, and in France hogs, which are very fond of truffle, are employed for the same purpose. The truffles chiefly sought after are black and white in colour. The table shows how these two varieties differ in chemical composition. It will be observed that both kinds contain a considerable quantity of nutritive material, much more than mushrooms. They are somewhat indigestible, and are principally used for stuffing and sauces.

LICHEN AND SEA-WEED.

Iceland-moss (*Cetraria islandica*) is a lichen, growing in high latitudes on barren rocks. Its composition is shown in the following table:—

Average percentage Composition of Iceland-moss.

Water	10·0	
Nitrogenous	8·7	
Starch	70·0	
Acids	6·3	
Fibre	3·5	
Saline	1·5	(Church).

This table indicates that Iceland-moss is of very high nutritive value, and it is frequently made use of, in times of scarcity, by the inhabitants of the rocky coasts where it is found. The acids it contains give it a bitter taste. For use, therefore, it is prepared by steeping in water with a little soda, by which the bitterness is removed. Thereafter it is stewed in water, milk, or soup till it becomes tender and mucilaginous. A spirit may be distilled from Iceland-moss after fermenting the sugar, which may be obtained after transformation of the starchy ingredient. The starch may be transformed into sugar by boiling with weak sulphuric acid.

Reindeer-moss (*Cladonia rangiferina*) is also edible. It is found in mountainous parts of Britain, and in high northern latitudes where it forms almost the sole winter food for reindeer. It also forms a jelly-like substance when cooked.

Rock Tripe (Tripe de roche) is another edible lichen, resorted to for sustenance by Arctic voyagers in distress or by the Arctic hunters of North America.

Irish or **Carrageen Moss** (*Chondrus crispus*) is a sea-weed collected from the rocky shores of the north of Ireland, and found also on the rocky coasts of Britain. Its composition is given in the following table:—

Average percentage Composition of Carrageen Moss.

Water	18·8	
Nitrogenous	9·4	
Gum, &c	55·4	
Fibre	2.2	
Saline	14·2	(Church).

The carbohydrate is in the form of a gummy material, which causes the moss, when steeped in boiling water, to form a stiff jelly. Before being cooked it should be steeped for some hours in cold water. The moss contains some iodine and sulphur, which render it useful in scrofulous conditions.

Laver is a general term applied to sea-weeds. **Green Laver** (*Ulva latissima*) is a common British sea-weed. *Porphyra vulgaris* and *laciniata* (sloke) are other species.

Sea-girdle (*Laminaria saccharina*), also called tangle and sea-wand, is abundant on British coasts. From it mannite, a sugary substance, is obtainable.

Bladder-lock (*Alaria esculenta*) is another sea-weed used as food. *Fucus vesiculosus*, bladder-wrack, has obtained some reputation for reducing corpulency. A liquid extract, called "Anti-Fat," has been advertised for this purpose. Many other sea-weeds, Ceylon moss, Chinese moss, Corsican moss, are also used for food. They are either boiled, after soaking in water, as already described, or pickled and eaten with pepper, vinegar and oil, or with lemon-juice.

II. Non-Nitrogenous Vegetable Foods.

STARCHES OR FARINACEOUS SUBSTANCES.

Starch is derived only from vegetable products. Preceding tables of composition show how abundantly it exists in grains, roots, and tubers, such as wheat, rice, potatoes, &c. In these substances it exists associated with nitrogenous material, but from this material it may readily be separated in a state of purity. For example, in the description of flour it has been shown how the starch may in a very simple way be separated from the gluten. In these food-stuffs the starch exists in the form of granules lying in compartments formed by a nitrogenous material. A starch granule consists of alternating layers of granulose and cellulose, both of which substances are starches; but the latter is extremely insoluble, while the former is dissolved by dilute acids and also by the ferments of the digestive tract. An envelope of cellulose is the outermost layer, and it is ruptured by boiling.

Starch Grains.—Under the microscope a typical starch grain appears as represented in the figure (Fig. 227), the concentric rings being the alternating layers of granulose and cellulose, and the point round which these rings circle is called the hilum. Now starch exists, as has been said, in a great variety of structures; but the granule of starch varies in size and in appearance according to the plant from which it has been obtained. Thus the starch granule obtained from the potato is very easily distinguishable from that obtained from wheat; both are easily distinguished from the starch grain of Indian corn, and so on. Now the size of the starch grain of all the starches generally used has been very carefully and accurately measured and the appearances well determined, so that it is quite possible to take a mixture of several starches, and after microscopic examination to state definitely the sources of the various kinds in the mixture. If, for example, wheat flour has been adulterated with potato starch, the detection of this is quite easy. In the same way the different kinds of arrow-root can be readily determined under the microscope. The various kinds of starch grain in some of the commoner farinaceous substances are shown on p. 598.

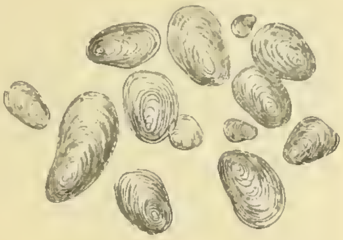
Fig. 227.—Potato Starch Granules.

Starch consists chemically, as explained (p. 536), of carbon, hydrogen, and oxygen only, the hydrogen and oxygen being in proportions to form water. No nitrogen exists. Thus, while starch is eminently valuable for the liberation of heat and energy, by its carbon and oxygen uniting to form carbonic acid gas, and hydrogen and oxygen uniting to form water, it is of no value for the development or repair of tissues. The impossibility of any food-stuffs, such as corn-flour, arrow-root, &c., which consist almost entirely of starch, being made an exclusive food-stuff for any age, is therefore apparent. Starch grains when boiled with water swell up, the cellulose envelopes are ruptured, and the more soluble granulose allowed to come into contact with dissolving juices. After heating in this way starch becomes soluble. Heating to a high temperature converts starch into a form of sugar, and it undergoes a similar conversion when heated with certain acids. This transformation occurs rapidly when starch is brought into contact with ferments, such as the diastase of grain, the ptyalin (p. 143) of saliva, and a ferment in the pancreatic juice (p. 145). It is only when starch has undergone this conversion, either without or within the body, that it becomes useful for purposes of nutrition. Unless the starch granules have been swollen and ruptured by previous boiling with water this conversion cannot readily occur, because of the insoluble nature of the cellulose envelope. The proper cooking of starchy substances is, therefore, of vital importance.

Fig. 228.—Sago-palm (*Sagus lævis*).

Sago is the starch obtained from various species of palm. The chief are the sago palms (Fig. 228) (*Sagus Rumphii* and *Sagus lævis*), which grow in the islands of the Indian Archipelago, Madagascar, and New Guinea; but from *Cycas revoluta*, a tree common in India, Australia, and tropical America, a coarse sago is also prepared, as well as from other palm-like trees. The trees are cut down just before the appearance of the flower-bud, and the pith, in which chiefly the starch is present, is extracted and reduced to a coarse powder. It is then mixed with water, washed and strained, and the starch allowed to settle. The sediment is then dried, and is the sago flour. Before being sent to the market it may be put through various other processes. It is mixed with water and rubbed into the granular form, which is called granulated sago. Pearl sago is produced by other means, probably with the aid of heat. Sago bread is made by putting the dry meal into heated earthenware moulds, in which it becomes formed into a cake. The *Sagus lævis*, which yields the finest kind, grows in forests in the Moluccas. A single tree will yield as much as from 500 to 800 pounds of sago. Sago is never perfectly free from water, of which, indeed, it contains something like 18 per cent. It also contains 1 to 2 per cent of saline material, the remaining 80 per cent being dry starch. According to Dr. Ed. Smith there are

2555 grains of carbon in 1 lb. of sago;

that is to say, $\frac{4}{5}$ths of the pound of sago are pure starch.

Sago is a very bland food, easily digested, and wholesome, but, it must again be repeated, is entirely unsuited for a chief article of food because of its want of nitrogenous constituent.

Corn-flour or Indian-corn flour, is obtained from Indian corn (see p. 565). It is the starch of the Indian corn, from which by various processes the nitrogenous constituent and bitter element have been removed. It still retains a trace of albuminous material, but not sufficient to be taken into account, in one sample only 18 grains being detected in one pound of the flour. Of pure starch it contains about the same quantity as sago.

Arrow-root is the starch obtained from the tuberous root of a West Indian plant, *Maranta arundinacea* (Fig. 229), now largely grown in Barbadoes, St. Vincent, and Bermuda. It was called the arrow-root plant, it is said, from the belief of the Indians that the root was an antidote to the arrow-poison, if the fresh roots were applied to the wound.

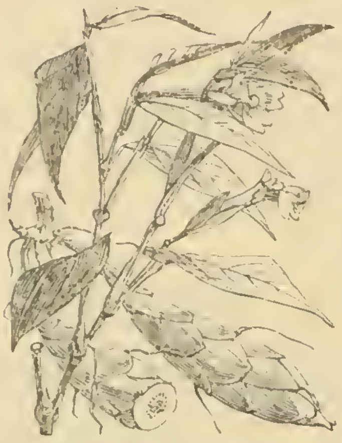
Fig. 229.—Arrow-root Plant.

The tubers when twelve months old are dug up, "well washed in water, and then beaten in large, deep, wooden mortars to a pulp. This is thrown into a large tub of clean water. The whole is then well stirred and the fibrous part wrung out by the hands and thrown away. The milky liquor, being passed through a hair sieve or coarse cloth, is suffered to settle, and the clear water is drained off. At the bottom of the vessel is a white mass, which is again mixed with clean water and drained; lastly, the mass is dried on sheets in the sun." The root furnishes about 26 per cent of starch. The Bermuda arrow-root is most esteemed. Other starches, sold as arrow-root, however, are made from quite different plants, and their source can always be determined by the use of the microscope.

English or **British Arrow-root** is potato starch.

Portland Arrow-root is starch made from the bulb of *Arum maculatum* (Fig. 230), the common "wake-robin," "cuckoo-pint," or "lords-and-ladies." It is manufactured in the island of Portland. An acrid material contained in the bulb is removed by washing.

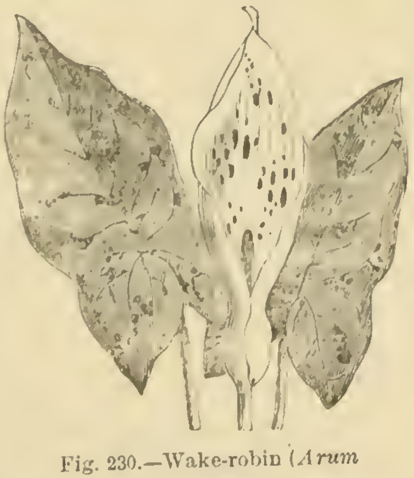
Fig. 230.—Wake-robin (*Arum maculatum*)

Brazilian Arrow-root is the flour of *Manihot utilissima* (Fig. 232), from which tapioca is prepared—the cassava or tapioca plant, belonging to the natural order *Euphorbiaceæ.*

East Indian Arrow-root is obtained from the tubers of *Curcuma angustifolia*, one of the ginger family of plants, and a species of turmeric.

Tacca Arrow-root or **Tahitan Arrow-root** is derived from *Tacca oceanica*, a native of the South Sea Islands, of the order *Taccaceæ.* Another of the species, *T. pinnatifida* (Fig. 231), found in Asia, yields a starch much used by the natives.

Tous-les-mois or **Canna Arrow-root** is yielded by the tubers of *Canna edulis*, a native of the West Indies, of the same order as the plant which yields the true arrow-root, *Marantaceæ.* It is imported from St. Kitto.

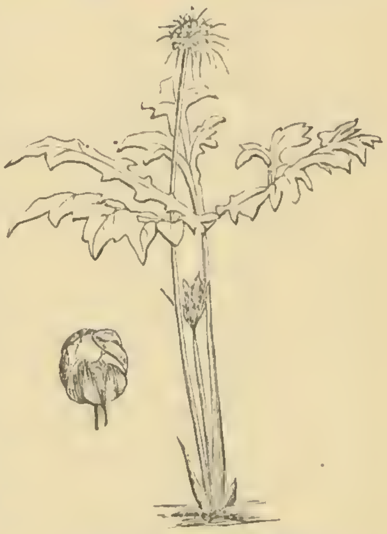
Fig. 231.—Tacca pinnatifida.

Maize Arrow-root is the same as corn-flour.

Rice Arrow-root is the starch of rice, called also rice flour.

The same remarks apply to it as to other starches. It consists of about 82 per cent pure starch.

Tapioca or **Cassava** is the starch from the *Manihot utilissima*, already noted as the source of Brazilian arrow-root. It is a native of tropical America, and is also cultivated in India, Africa, and other tropical countries. The plants contain a bitter poisonous substance, which is removed by washing. The root is washed and scraped, and then reduced to a pulp by being rasped or grated. It is then squeezed to remove the juice. The pulp is then dried and forms cassava powder or manioc. Made into cakes it is called **cassava bread.** The cassava meal dried on hot plates forms irregular little lumps, and this is the tapioca.

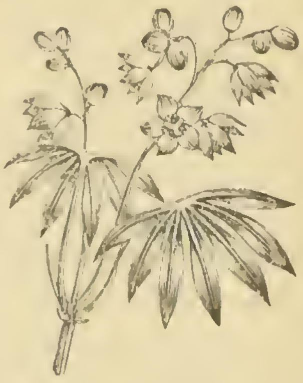
Fig. 232.—Cassava Plant (*Manihot utilissima*).

Salep or **Salop** is the dried tubers of eleven species of orchid, *O. mascula* (Fig. 233), *maculata*, *latifolia*, *morio*, and others. It is imported from Persia and Asia Minor, and is largely used in Turkey and Eastern Europe as food. It occurs in small oval bulbs, whitish-yellow in colour, hard, and semi-transparent, tasting like gum tragacanth, and with a faint peculiar smell. It is ground into powder and boiled with water, milk, and sugar, like other white-puddings. Its exact composition is not stated.

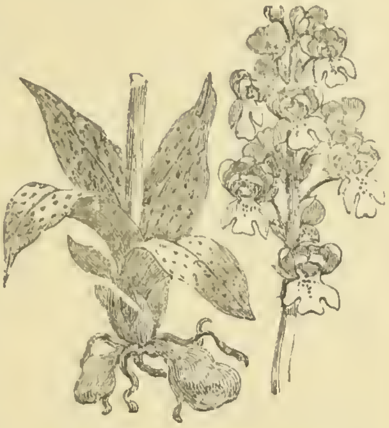

Fig. 233.—Salep (*Orchis mascula*).

SUGARS.

Sugar is a compound of carbon, hydrogen, and oxygen. There are two chief forms of it—the grape-sugars or glycoses, and the cane-sugars, sucroses or saccharoses. To the former class belong the fruit-sugar, to which specially the name glucose, glycose, dextrose, or grape-sugar is given, the sugar found in flesh called inosite, and it is the kind of sugar passed out of the body in the disease diabetes (p. 303). Laevulose, mannitose, galactose are other varieties of grape-sugar. Grape-sugars crystallize with difficulty forming warty little masses, or not at all, and in this they are markedly distinguished from the cane-sugars, which form beautiful crystals. The granular appearance of honey is due to the concretions of the grape-sugar of which it mainly consists.

Of cane-sugars the chief examples are derived from the sugar-cane, beet-root, and other roots, and the birch and maple. Milk-sugar, or lactose, the form in which sugar exists in milk, and maltose, a kind of sugar formed during the fermentation process in the transition to glucose, also belong to the cane-sugar group. Cane-sugar crystallizes readily in prismatic forms. It is more sweetening than grape-sugar.

Another distinguishing feature is that grape-sugar ferments readily; when submitted to the action of yeast it is transformed at once into carbonic acid gas and alcohol. On the other hand cane-sugar requires first to be converted into grape-sugar before it undergoes fermentation. Starch requires to be similarly transformed. In the human body both starch and cane-sugars require similar conversion, under the ferment action of the saliva or pancreatic juice, before they are available for purposes of nutrition. The starch is first transformed into dextrin, a gummy substance, having the same chemical composition as starch, and classed among the starches, but differing from it in being completely soluble in water, and then the transformation to glucose is effected. This same transformation of starch to dextrin, and dextrin to glucose, is effected by the action of the diastase of the wheat grain on the starch of the grain, produced during germination.

Cane-sugar.—The ordinary sugar of commerce is obtained from the sugar-cane (*Saccharum officinarum*), belonging to the natural order of the grasses, *Graminaceæ.* It is a native of India, whence it was transported to Cyprus about the middle of the twelfth century. From Cyprus it reached Madeira, and was transported to America about the beginning of the sixteenth century. It grows 18 to 20 feet in height, has jointed stems, has large firm thin leaves and numerous flowers (Fig. 234). When grown for sugar, however, they are rarely allowed to come to flower, young plants being produced by offsets from the stem of older ones. It is in the stem of the cane that the sugar abounds, the composition of the stem showing—

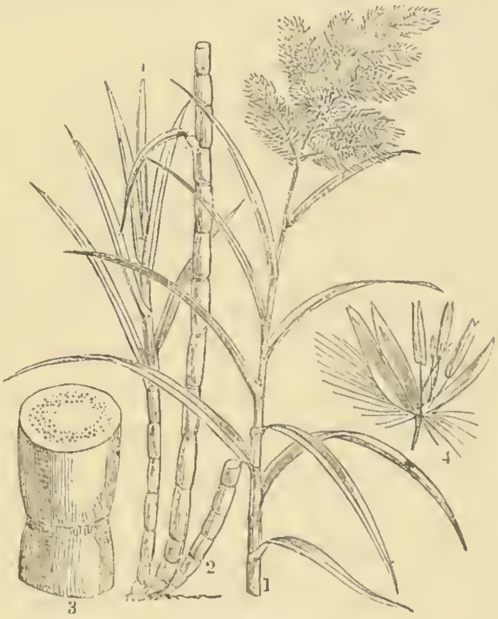

Fig. 234.—Sugar-cane.

1, Stem from entire plant in flourish. 2, Cane with leafy offset. 3, Piece of mature cane. 4, A spikelet of the flourish.

Sugar	18	per cent.
Water	72·1	,,
Woody fibre and salts	9·9	,,

From many other plants may cane-sugar be obtained. The stem of the Chinese sugar-cane (*Sorghum saccharatum*) contains it to the extent of 9 to 9½ per cent. "A closely-allied species, called imphee, is grown by the Zulu Kaffirs, and yields not only sugar in its stems but much valuable starchy food in its seeds." The juice from the stems of maize, cut shortly after flowering, contains cane-sugar to the extent of 3 to 4 per cent. The stems of the American rock-maple (*Acer saccharinum*) yield cane-sugar in richest quantity in early spring. Two holes are drilled in the tree about 20 inches from the ground, and wooden spouts driven into them, by which the ascending sap flows out into troughs placed to receive it. In this sap cane-sugar is present to the extent of 2 per cent. From the stem of the sago-palm (see p. 585) cane-sugar has also been extracted. **Jaggery** is the name applied to a sugar obtained from the juice of various palms, the cocoa-nut palm, the date-palm, the wild date-palm (*Phœnix sylvestris*), and *Caryota urens*, an inferior sago-palm. In roots and tubers of various other plants is it found. Chief of these is the beet-root, the sugar beet, or mangold-wurzel (*Beta vulgaris*). It yields 7 to 11 and even 14 per cent of cane-sugar. The manufacture of beet-sugar is largely carried on in France, Belgium, and Russia, a total of 700,000 tons of beet-sugar being, it is said, prepared in Europe annually, about half the total European import of cane-sugar. Cane-sugar may also be obtained from hazel-nuts, walnuts, coffee-beans, and locust-beans, carob-beans or St. John's bread, which contains it to the extent of 51 per cent (that is, the dry bean).

The following terse account of the method of preparing sugar from the cane is taken from Watt's *Dictionary of Chemistry*. The ripe canes cut close to the ground and stripped of the leaves are crushed between rollers, and the expressed juice, which is apt to run quickly into fermentation by the action of the albuminous matters which it contains, is purified by heating it in a copper boiler to about 140° Fahr., with a small quantity of lime. The impurities then form a scum, which is removed as fast as it collects. The juice, when sufficiently clarified, is rapidly concentrated to about 23° of the hydrometer, then passed through cloth filters and evaporated to a very thick syrup, which is run into shallow vessels to accelerate cooling, then poured into vessels having their bottoms pierced with holes which are kept plugged. The syrup, after being left at rest for some hours, is agitated to promote the crystallization of the sugar, and as soon as it has set into a solid mass, the plugs are removed to allow the still remaining liquid to run off, and the syrup is again boiled till it no longer yields any crystals. The last mother-liquors, which are thick, brown, and refuse to crystallize, are called molasses or treacle, and are used chiefly for the preparation of rum. The solid sugar, obtained as above, is sent to Europe under the name of raw sugar, or Muscovado sugar. It is a yellowish granular powder, still impregnated with treacle, and often contaminated with foreign substances, which impart to it a more or less disagreeable taste; hence it requires refining.

The formation of molasses is entirely due to the conversion of cane-sugar into uncrystallizable sugar by the heat to which the juice is subjected; the fresh juice of sound canes contains nothing but crystallizable sugar. Great improvements have recently been effected in the methods of boiling down syrups, especially by the use of vacuum-pans, whereby a beautiful crystallized product is obtained from the juice at the first evaporation, and the formation of molasses is greatly diminished. To obtain pure, colourless, crystallized sugar from raw sugar, the latter, dissolved in about a third of its weight of water, is mixed with a small quantity of milk of lime, and heated to the boiling point; and the juice is decanted from the impurities, which separate in the form of a crust, then filtered through bone-charcoal, and evaporated in a vacuum-pan. The strongly concentrated juice is made to crystallize by moderating the heat and running in small quantities of unthickened juice, whereupon a magma of sugar-crystals immediately forms. To give them the requisite hardness, heat is again applied, the crystalline magma is left to drain in the sugar-loaf moulds, and the formation of small uniform crystals is promoted by stirring and breaking up the crust which forms on the surface. When the crystallization is complete, the apex of the mould, which has previously been closed, is opened, to allow the syrup to drain off, and that which remains adhering to the crystals is displaced by pouring in pure sugar syrup. By due desiccation (drying) the loaf-sugar or refined sugar of commerce is obtained.

Formerly the clarification of the syrup was effected by adding a certain quantity of the serum of bullocks' blood; on heating the syrup, the albumen of the serum became coagulated and rose to the surface, carrying with it the greater part of the impurities.

When it is not desired to make loaf-sugar the uncrystallizable syrup is removed by centrifugal machines, revolving drums covered with fine wire-gauze, caused to turn with great speed, by which the syrup is thrown out through the gauze, while the sugar is retained in the drum.

In the refining process treacle and golden syrup are obtained. Treacle is the uncrystallizable portion separated from the crystals in the draining process. It contains water, some crystallizable sugar in solution, saline matters and impurities, and about 65 per cent of uncrystallizable or fruit sugar, due to conversion of cane into fruit sugar by the heat. Syrup is clarified treacle, obtained by re-boiling the treacle and filtering through animal charcoal. Coloured moist sugars are less refined qualities, containing more water, uncrystallizable sugar, and various impurities. Sugar in the largest crystals is of the purest kind; sugar-candy is the purest kind of sugar. There is always a proportion of water in sugar, roughly indicated by the degree of moisture. The purest white sugar contains 99·92 per cent of sugar, the remainder being ·069 per cent of absorbed moisture, 1·02 per cent of ash. In inferior qualities the quantity of sugar may be reduced to 94, 88, 80, and 67 per cent. The sweetening qualities of sugar will, therefore, vary; and the diminished sweetening quality of the inferior kinds is marked, because of the considerable proportion of fruit-sugar they contain, whose sweetening property is much less than that of cane-sugar.

There are 2800 grains of carbon in 1 pound of moist sugar.

Caramel is produced from cane-sugar by heating to 1600° Fahr., by which water is driven off, the sugar ceases to be able to crystallize, is dark coloured, and becomes bitter in taste. It is used by cooks for flavouring and colouring.

Honey is a vegetable product. It is the sweet juice produced in the nectaries of plants at the base of the petals. It appears simply to be collected and stored by the bees, and not to undergo any chemical change while it remains in the honey-bag of the bee, which is a dilatation of the gullet or œsophagus. The quality of the honey is therefore mainly affected by the nature of the plants from which it is obtained. "In Scotland the best honey is gathered in the months of June and July, when the white clover (*Trifolium repens*) is in bloom; and what is stored in spring, or rather in April and May, is finer and better flavoured than what is obtained in autumn, unless the bees have been during the latter season within reach of heath, the honey from which is of a rich wild flavour, but of a darker colour. The quality of honey is, of course, much influenced by the nature of the plants most frequented by the bees. The famed honey of Hymettus derives its excellence, it is said, from the wild thyme growing so luxuriantly on the celebrated mountain from which it derives its name; that of Narbonne, from the wild rosemary (*Rosmarinus officinalis*). The white Dutch clover and the heath have been already noticed as furnishing honey of a superior kind; and there is a district in Galloway, North Britain, where perhaps the best honey in the kingdom is produced, owing, it is supposed, to the great abundance of wild thyme (*Thymus serpyllum*) with which the country abounds." Honey of a deleterious nature is sometimes met with. "Towards the close of the year when flowers become scarce, and in those parts of the country where alders abound, and where onions and leeks are cultivated on a large scale, and allowed to run to seed, the bees, from taste, or from necessity, or from anxiety to complete their winter stores, are seen to feed on these plants, which communicates to the honey a very disagreeable flavour. But this is not all. The fact stated by Xenophon in the *Retreat of the Ten Thousand*, and confirmed by Diodorus Siculus, proves that there are plants in Asia Minor which give to the honey, not only disagreeable, but poisonous qualities. He tells us that the soldiers, having eaten a quantity of honey in the environs of Trebizonde, were seized with vertigo, vomitings, &c. This effect was attributed to the rose-laurel (*Rhododendron ponticum*), and yellow azalea (*Azalea pontica*). Father Lamberti also assures us that a shrub of Mingrelia produces a kind of honey which causes very deleterious effects. It is quite possible that the poisonous juices extracted from these plants might be innocuous to the bees themselves. . . . Sir J. E. Smith asserts that the nectar of plants is not poisonous to bees, and an instance is given, in the *American Philosophical Transactions*, of a party of young men who, induced by the prospect of gain, having removed their hives from Pennsylvania to the Jerseys, where there are vast savannahs, finely painted with the flowers of the *Calmia angustifolia*, could not use or dispose of their honey on account of its intoxicating quality; yet 'the bees increased prodigiously;' an increase only to be explained, says Dr. Bevan in his *Honey-Bee*, by their being well and *harmlessly* fed."

Bees are found in all temperate and warm climates. The bee cultivated in Europe is the *Apis mellifica;* the red honey of Surinam and Cayenne is produced by the *Apis amalthea;* and in Madagascar honey of a greenish colour is obtained from the *Apis unicolor*, a black bee.

Honey consists of cane-sugar, fruit-sugar or glucose, and inverted sugar (a mixture of two varieties of glucose, namely dextrose and lævulose). Along with these there is also a trace of flavouring and colouring substances and wax. There are also pollen from the plant "and invariably minute quantities of alcohol." The total quantity of sugar, mainly grape or fruit sugar, is not less than 73 per cent, and there is not more than 27 per cent of water.

Virgin Honey is the term applied both to honey from young bees that have never swarmed, and to honey obtained from the comb without the aid of heat or pressure, simply by allowing it to drain from the comb.

Honey which has been kept for some time, or has been obtained from the comb by the aid of pressure and heat, crystallizes owing to the formation of the small warty masses of dextrose. It is less delicate in flavour than clear virgin honey.

Mead, or metheglin, is an alcoholic liquor obtained by the fermentation of honey, varying in sweetness according to the extent to which the fermentation has been carried. It was a drink much consumed in England in olden times.

Manna is a sugary exudation from certain plants and trees, especially of the ash tribe. The manna of commerce is obtained chiefly from two kinds of ash, *Fraxinus ornus* and *Fraxinus rotundifolia*, by making incisions in the stems of the trees. The juice escapes and dries into crystalline masses, which are collected. The trees are cultivated for the purpose chiefly in Sicily and Calabria. A similar substance can be obtained from the common ash (*Fraxinus excelsior*). Other sugary exudations, known under the name of manna, are obtained from other sources, Briançon manna from the leaves of the common larch (*Larix europæa*), another from Mount Lebanon, from the branches of *Pinus cedrus*. Manna is also yielded by the *Eucalyptus mannifera*, the dwarf oak, tamarisk, and other plants. That of the last named is called **Manna tamariscina**, or **Manna Israëlitarum**, and is believed by Landerer to be the manna mentioned in the Old Testament. "He informs us that this exudation is produced by the puncture of *Coccus manniferus*, an insect inhabiting the trees of *Tamarix mannifera*, which grow abundantly in the neighbourhood of Mount Sinai. The manna exudes as a thick transparent syrup, covering the smaller branches from which it flows. It is collected by the monks of the district in the month of August. The collection takes place very early in the morning, at which time, owing to the coolness of the night, the saccharine juice has become to some extent congealed. The tamarisk manna is eaten in Palestine and in the district of Sinai as a delicacy." The manna may be shaken from the trees on which it has collected before sunrise, into cloths spread underneath. It is also found upon sand and stones; and in the state in which it is found it resembles coriander seed. **Honey-dew** is a similar sugary exudation found on many plants, principally oak, elm, plane, lime, beech, and fruit trees and evergreen plants. It is found at the close of summer on very sultry evenings.

Manna consists largely of a peculiar kind of sugar, called mannite; according to one authority 60 per cent is mannite, and a large percentage of uncrystallizable sugar; according to another analysis the tamarisk manna consists of cane-sugar 55 per cent, inverted sugar 25 per cent, and dextrin (a gum) 22·5 per cent.

It has an aromatic flavour, and is now chiefly used as a mild laxative for children, from 60 grains up to $\frac{1}{2}$ ounce being the dose.

VEGETABLE OILS.

Oil is yielded by a very large number of vegetable products, from nuts like the palm-nut, the walnut, almond, hazel-nut, ground-nut, from other fruits like the olive, and especially from seeds, such as those of the cotton plant, mustard seed, cucumber seed, rape seed, &c.

To understand the richness of some of these in oil reference need only be made to the tables on pages 580 and 582, where it is found that the quantities of oil yielded by 100 pounds of the substances are very great. Thus—

100 pounds of			
Filberts	yield over	66	pounds of oil.
Walnuts	,,	62	,,
Almonds	,,	53	,,
Ground-nuts	,,	50	,,
Cocoa-nuts	,,	35	,,

To these we may add the following—

100 pounds of			
Palm-nut (pulp)	yield	72	pounds of oil.
Sesame seeds	,,	51	,,
Olives (kernels)	,,	44	,,
Linseed	,,	38	,,
Cotton seed	,,	24	,,
Sunflower seeds	,,	22	,,

Olive-oil is expressed from the pulp of the ripe olive, the fleshy exterior of the fruit. The common olive-tree (*Olea europæa*, Fig. 235) is a native of Syria, and is cultivated in Italy, France, Spain, Turkey, &c. It is a pure bland oil, well suited for domestic purposes. The first oil pressed from the ripe fruit is greenish in colour, and is the finest—virgin oil it is called. Provence oil (produced in Aix), Florence oil, Lucca oil, Genoa oil, and Gallipoli oil, are all olive-oils of good quality, the first being most esteemed. Sicily oil is also olive-oil of an inferior quality, and Spanish oil is the worst kind, being used for machinery. The olive fruit itself is not only used for obtaining oil but is preserved as a pickle, and used after dinner to refresh the palate for the taste of wine. The fruit is pickled while still green—the ripe fruit is black—it is soaked in strong soda solution to remove a bitter principle, then in fresh water, and afterwards transferred to a solution of salt in which it is preserved.

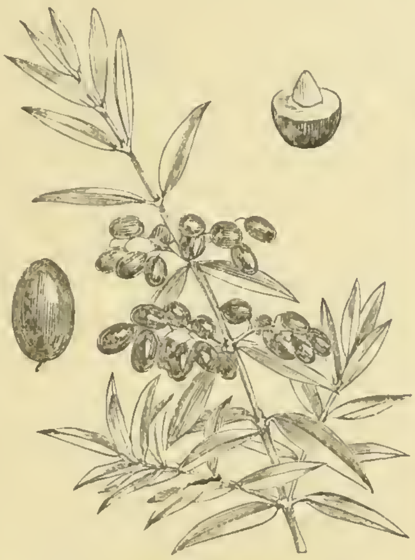
Fig. 235.—Olive (*Olea europœa*).

Palm-oil is mainly used in Britain as a lubricant. It is, however, used on the Gold Coast as a butter, and when pure and fresh is wholesome. It is obtained from several species of palm, chiefly the oil-palm, *Elæis guineensis* (Fig. 236), the oil being expressed from the fruit, palm-nuts.

Fig. 236.—Palm-oil Tree (*Elæis guineensis*).

Fig. 237.—*Sesamum orientale* (Sesame).

Sesame-oil is a fine bland oil, used in India as an article of food, and elsewhere for burning in lamps, as well as for adulterating olive-oil. It is expressed from the seeds of *Sesamum orientale* (Fig. 237), natural order *Pedaliaceæ*, native to India and also cultivated in Egypt and Syria.

Cotton-seed Oil, unlike linseed-oil, is an extremely pleasant oil, and fitted to be used as a food-stuff. It is cheaper than lard, and might with great advantage be used instead of it for cooking in oil. "The very best lard," Williams says, "or ordinary kitchen butter, eaten cold has more of objectionable flavour than refined cotton-seed oil." Moreover, the present price of the best refined cotton-seed oil is 3½*d.* per lb., while lard costs 6*d.* per lb. wholesale. It is expressed from the seeds of *Gossypium barbadense*, of the natural order *Malvaceæ*.

Cucumber-seed Oil. Common cucumber (see p. 574) seeds also yield an oil, said to be of delicious and delicate flavour, and the large cucumber grown on the African coast yields from its seeds an oil which "far exceeds in flavour the finest olive-oil."

Shea or **Galam Butter** is a vegetable fat obtained from the nuts of *Bassia Parkii*, of the natural order *Sapotaceæ*, natives of India, Africa, and America. The sapodilla plum is the produce of a species of the same order, which is rich in trees and shrubs useful for alimentary purposes. A species of the same order is the tree which produces the gutta percha of commerce, *Isonandra gutta.* The nuts of *Bassia Parkii* are shelled, and the kernels, which consist almost wholly of fat, are boiled with water and pressed. The fat is greenish white, and solid at ordinary temperatures, and has a mild pleasant flavour. Many other kinds of Bassia yield oils which, in the Gaboon and elsewhere where they are produced, are used by the natives as an external application for rheumatism.

III. Condiments.

Condiments are substances which are not foods in themselves, but are taken with foods for the purpose of aiding their flavour.

The chief condiment is salt. It, however, stands on quite a different level from the others. It is a necessity, and its importance has been already dwelt on (p. 539). The other condiments we might classify in the following way:—

Acids: Vinegar, lemon-juice, pickles, &c.

Pungent substances: Pepper, mustard, ginger, curry, horse-radish.

Aromatics: Cinnamon, nutmegs, cloves, allspice, mint, mace, parsley, cardamoms, thyme, caraway, coriander, angelica, marjoram, fennel, dill, anise, sage, vanilla, turmeric, chervil, cumin, capers, onion, garlic, shallot, chives, savory, tarragon.

None of these is necessary for foods. They are added for the purpose of giving a fillip to the appetite, and where there is any feebleness of appetite they cause more food to be eaten than would otherwise be. They also relieve the monotony and sameness of food, and where natural appetite is wanting they act beneficially in this way. They also act upon the mucous membrane of the stomach, and stimulate the flow of blood to the glands and of gastric juice; and thus undoubtedly they will stimulate digestion, where such stimulation is needed. Vinegar, by the addition of acid which it makes, will also further aid digestion where the acidity of the gastric juice is too feeble. In a state of health, however, there is no need for such stimulation, and if they are resorted to, to any great extent, specially the more active condiments, the stomach and bowels are likely to become so used to their sharp stimulating action that they will not respond to any less active stimulant. The mere entrance of the food into the stomach is, in health, the only incitement required to promote the flow of the gastric juice, but will be totally insufficient for the stomach accustomed to the rousing action of spices, curries, and aromatics of various kinds. They ought, therefore, always to be employed with great moderation, and the milder of them rather than the more active and pronounced. They should not be permitted to children at all.

Vinegar owes its acid properties to acetic acid, of which it ought to contain 5 per cent, that is, 5 per cent of the pure crystallizable acetic acid, which is also called glacial acetic acid. There are two chief processes by which vinegar is made. The first is by conversion of alcohol into acid, which is effected by the acetic acid fermentation, now known to be due to the activity of an organism, the *Mycoderma vini*, just as alcohol is the result of a fermentation due to the activity of another organism, the *Torula cerevisiæ* (p. 389). So that vinegar is made from sugar, or starch which has been converted into sugar, after it has undergone two fermentations, first into alcohol and second into acid; and the souring of wines is the result of the production of acid by the agency of organisms which have gained access to the wine. The material from which vinegar is produced by this fermentive process is either wine or malt, and thus there are **Wine-vinegar**, produced on a large scale in France, and **Malt-vinegar**, produced in England. The second process is by the destructive distillation of wood. This produces **Wood-vinegar**, or **Pyroligneous Acid.** The flavour of the particular vinegar depends upon its source. For, besides the 5 per cent of pure acetic acid which it ought to contain, and water, which makes up almost the remainder of its bulk, there are present in minute quantity various substances dependent upon the source of the vinegar, which give it the special flavour it may possess, as well as salts, extractive matter, alcohol, sugar, gum, and probably some colouring matter purposely added by the manufacturer. Flavouring essences are also frequently added.

Wine-vinegar is prepared from grape juice and inferior new wines, that made from white wine is specially desired. The wine is kept in large casks at a fixed temperature, and the fermentation occupies generally a fortnight. Thereafter the vinegar is run off into barrels, in which are several chips of birch wood, and there clarified. Or the wine is placed in large casks containing beech shavings, which afford space for the growing organism, and when the wine has become converted into vinegar, half is run off and the cask then filled up with more wine, so that the "mother" casks, as they are called, are never emptied, and the process of manufacture goes steadily on.

Malt-vinegar is obtained from a mixture of malt and raw barley, mashed with water, and allowed first to undergo the vinous fermentation, and subsequently the acetic acid fermentation. A long time—weeks or months—is occupied in the process.

Vinegar may, of course, be made from sugar by submitting it to the double fermentation. It might, therefore, be called **sugar-vinegar.**

Wood-vinegar is made by heating wood in large iron cylinders, which are connected with condensers. The liquid which passes over from the cylinders consists of wood spirit, acetic acid, water, and tarry products. By redistillation the pyroligneous acid is separated out in a crude state, containing tarry matter. By various chemical processes the acetic acid is separated from the tar by conversion into acetate of sodium, the acetic acid then liberated by decomposition with strong sulphuric acid, and finally purified by distillation.

Vinegar usually contains some sulphuric acid, added to prevent decomposition, though that has been shown to be unnecessary, and allowed by law to the extent of one-thousandth part by weight. It is usually sold in four degrees of strength, called Nos. 18, 20, 22, and 24, of which the last is the strongest, and is the best for pickling. No. 22 is the best for the table.

Vinegar is used by itself, also in the preparation of sauces, and for the making of pickles, for which all kinds of vegetables may be used. Copper has been added to vinegar in order to give the vegetables a bright green colour. It is, of course, injurious, and its presence may be detected by inserting the bright blade of a steel knife, which will become coated with the coppery colour. It is useful for allaying thirst and checking excessive perspiration. It is a popular remedy for corpulence, and does, when habitually taken, cause diminution of stoutness to occur, but by interfering with the digestive process and producing a failure of nutrition. Used regularly for such a purpose it is undoubtedly hurtful.

Lemon and **Lime Juice** owe their special properties to the presence of citric acid, which is found also in the citron, orange, shaddock, and other fruits. It is prepared in England, and also in Sicily and the West Indies, some brandy being added to the juice to preserve it, and sometimes it is preserved by simple boiling. The juice should contain 32½ grains of citric acid in each fluid ounce, and with it there is malic acid, gum, extractives, and water. It is an agreeable and refreshing beverage, and is regularly employed in the merchant navy as a preventive of scurvy, 1 ounce of juice, 1 ounce of sugar, and half a pint of water being daily served out to each of the crew. An artificial lemon beverage may be prepared by dissolving 552 grains of citric acid in a pint of water and flavouring with essence of lemon; or the following: 1¼ oz. citric acid, 45 grains carbonate of potash, 2½ oz. white sugar, dissolved in 1 pint of cold water, flavoured with essence of lemon or the rind of a lemon, and after 24 hours strained through a hair-sieve or piece of muslin.

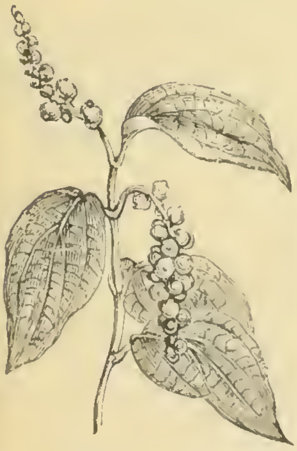
Fig. 238.—Black-pepper (*Piper nigrum*).

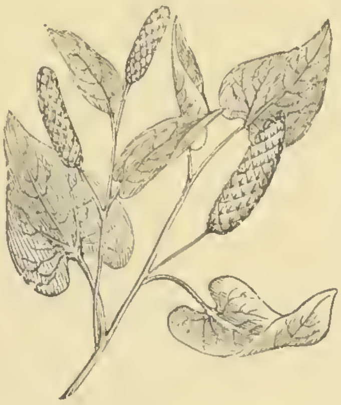
Fig. 239.—Long-pepper (*Piper longum*).

Pepper is the fruit of a set of herbs belonging to the natural order *Piperaceæ*, or pepperworts, which flourish in the tropics. **Black-pepper** is the fruit of *Piper nigrum* (Fig. 238), dried while still unripe. The plant is a climbing one, supporting itself on other trees, and growing to a height of 8 to 12 feet. Its berries pass from the green to the red stage and then become black, but previous to this they are gathered and dried in the sun; they occur in small clusters, 20 to 50 in each. **White-pepper** is the same fruit deprived of its outer husk. The best black-pepper comes from Malabar; but what is sold in the shops consists of a mixture of berries from different localities—Malabar, Penang, Sumatra, &c. **Long-pepper** is the fruit of *P. longum* (Fig. 239), native to Java, Malabar, and Bengal. **Jamaica-pepper**, or **Allspice**, or **Pimento** (Fig. 240), is the berry of *Eugenia pimenta*, belonging to the *Myrtaceæ* order, to which cloves, cajeput, guava, and eucalyptus belong. It is imported from Jamaica. Its peculiar aroma, supposed to resemble a mixture of cinnamon, cloves, and nutmeg, have earned for it the name of allspice. **Cayenne-pepper** is made from the powdered pods of *Capsicum annuum*, of the same order as potato, *Solanaceæ*. It is sold entire under the name of **Chillies**. It is native to America, and is imported chiefly from Zanzibar and Natal. Guinea-pepper, cherry-pepper, bell-pepper, goat-pepper are all obtained from different kinds of Capsicum.

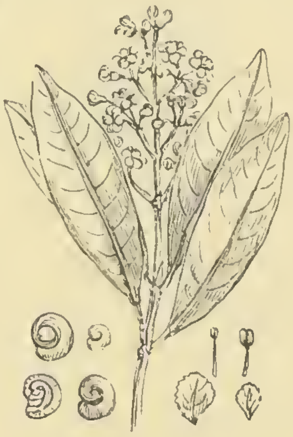
Fig. 240.—Pimento.

All these substances owe their peculiarities to the presence of an essential oil, which in black and white pepper exists to nearly 2 per cent.

Mustard is the finely ground seeds of *Sinapis nigra* or *alba*, black or white mustard, or a mixture of both. They belong to the cruciferous order. From the white mustard 36 per cent of a clear yellow odourless oil, void of all pungency, can be expressed, and from the black mustard 18 per cent. If the flour, left from the black mustard, be moistened with water a volatile oil is formed, which did not previously exist, to which the pungent qualities are due, and which is developed, owing to the moistening, from a substance called myronic acid. White mustard contains no such acid, and does not develop pungency by moistening. This volatile oil is produced only to the extent of ·2 per cent.

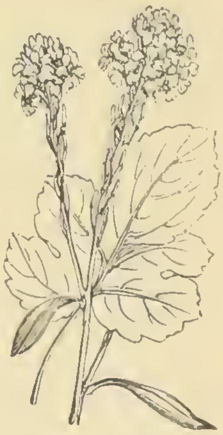
Fig. 241.—Mustard (*Sinapis nigra*).

Horse-radish (p. 572) belongs to the same order as mustard, and yields a volatile oil similar to that of black mustard.

Ginger is the scraped and dried root of *Zingiber officinale* (Fig. 242), of the order *Zingiberaceæ*, tropical plants, widely cultivated in East and West Indies, China and Africa.

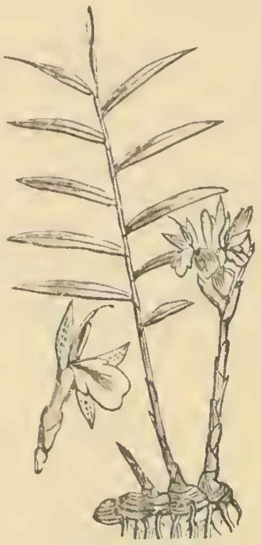

Fig. 242.—Ginger Plant (*Zingiber officinale*).

Curry of Ceylon is said to be a mixture of the following: a piece of green ginger, two fragments of garlic, a few coriander and cumin seeds, six small onions, one dry chilli, eight peppercorns, a small piece of turmeric, half a dessert-spoonful of butter, half a cocoanut, and half a lime; to have it in perfection it should be made on the day on which it is to be cooked. Ordinary curry powder is a mixture of turmeric, black-pepper, coriander seeds, cayenne, fenugreek, cardamoms, cumin, ginger, allspice, and cloves.

Belonging to the ginger order are some of the aromatic condiments.

Turmeric is an example, the root-stock of *Curcuma longa*, an East Indian plant, imported chiefly from Bengal and Peru. It is used both as a dye, of a yellow colour, and also as a condiment in powder. Its odour is due to an essential oil, which it contains to the extent of 1 per cent.

Cardamoms are also aromatic fruits of the ginger order. The medicinal cardamoms are derived from *Elettaria* (*Alpinia*) *Cardamomum*, Malabar cardamoms. A large kind (*Amomum angustifolium*) comes from Madagascar, a smaller (*Amomum cardamomum*) from Sumatra. **Grains of Paradise** or Ceylon cardamoms belong to the same order, and are the fruit of *Amomum melegueta*, a West African plant.

Of the aromatic group the following belong to the natural order *Umbelliferæ*:—

Parsley (*Apium Petroselinum*) is a native of Sardinia, yielding both a fixed and volatile oil.

Fennel (*Fœniculum vulgare*) grows wild on the Mediterranean shores, of which both seeds and leaves yield an essential oil: chopped leaves are sometimes served in melted butter to mackerel: cordials are flavoured with the fruit.

Cumin (*Cuminum cyminum*) is native to Egypt and Syria; the essential oil of cumin is used for flavouring cordials, and is obtained from the seeds: cumin resembles fennel.

Dill (*Anethum graveolens*), native to Southern Europe, very much resembles fennel. Its essential oil dissolved in spirit yields, when diluted with water, dill water, a useful and harmless agent for dispelling wind from the bowels of children.

Anise (*Pimpinella anisum*) is native to Asia Minor and Egypt, and cultivated in Spain and Malta. The fruit contains 2 per cent of essential oil, used for flavouring cordials: sugar flavoured with the oil is used for flatulence.

Caraway (*Carum Carui*) has a root like carrot or parsnip, and may be used as they are: seeds are imported from Holland: an essential oil is yielded by the seeds, and is used for flavouring cakes, confectionery, cordials, &c.

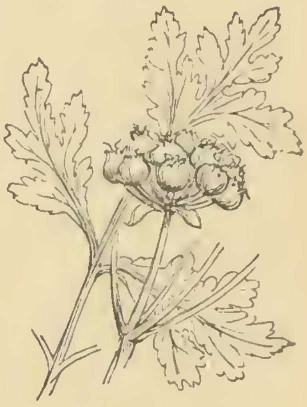

Fig. 243.—Coriander (*Coriandrum sativum*).

Coriander (*Coriandrum sativum*), native to Southern Europe, is cultivated in France: the seeds are used and yield also an essential oil.

Angelica (*Archangelica officinalis*), found in Northern Europe, possesses a large fleshy aromatic root, which is boiled in syrup and used as a sweetmeat; the seeds are used as flavouring agents for cordials, &c.

Chervil (*Anthriscus cerefolium*) or garden chervil, native to Britain, a hairy herb, is used for flavouring soups and salads; sweet chervil is *Myrrhis odorata*.

The natural order *Labiatæ* yields a large number of sweet, savoury, or pot herbs:—

Mint or **Spearmint** (*Mentha viridis*) and peppermint (*M. piperita*) and pennyroyal-mint (*M. pulegium*) all yield essential oils.

Thyme (*Thyma vulgaris*), a Mediterranean shrub; wild thyme (*T. Serpyllum*) is a British plant: the essential oil is called origanum oil.

Marjoram (*Origanum vulgare*) is a native of Britain: sweet marjoram is *O. marjorana*, and is much used for culinary purposes because of its fragrance.

Sage (*Salvia officinalis*), native of Southern Europe, is a garden plant; wild sage (*S. Verbenaca*) is a native of Britain, and also meadow-sage (*S. pratensis*).

Sweet Basil (*Ocymum basilicum*), native of India, is specially used in France for flavouring soups, sauces, &c., like the other pot-herbs.

Savory (*Satureia hortensis*) is a garden shrub cultivated in Europe for seasoning sauces.

To the order *Liliaceæ* belong the following:—

Garlic (*Allium sativum*), a bulbous perennial, native to Southern Europe, much resembles onion, but is of stronger flavour and odour: the bulb consists of ten or twelve "cloves" inclosed in a tough coat.

Shallot or **Eschalote** (*Allium ascalonicum*) is a native of Palestine, especially near Ascalon: it is one of the mildest of the onion tribe.

Chives or **Cives** (*Allium schœnoprasum*) is native to Britain, and is used as are leeks or onions.

Capers are the flower-buds of *Capparis spinosa*, of the natural order *Capparidaceæ*, growing in the south of Europe: it is a low wall plant, of which the flower-buds are collected before expanding and placed in vinegar.

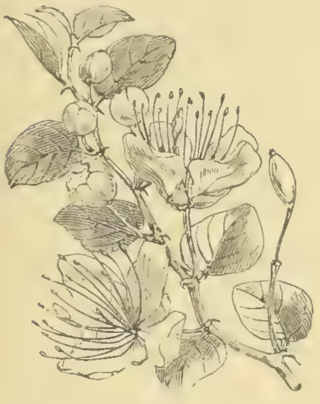

Fig. 244.—Caper (*Capparis spinosa*).

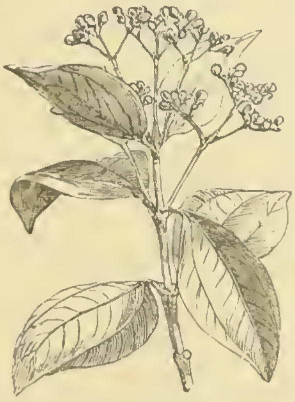

Fig. 245.—Cinnamon (*Cinnamomum zeylanicum*).

Cinnamon and **Cassia** are derived from the bark of a tree of the genus *Cinnamomum*, of the order *Lauraceæ*. The former is yielded by *C. zeylanicum*, an evergreen tree of Ceylon, Borneo, Sumatra, and the coast of Malabar. It is in the form of quills, the inner bark stripped from two-year-old shoots. Cassia is a Chinese species, the unripe fruit of which is "cassia buds." White cinnamon comes from a different order, being the bark of a West Indian tree, *Canella alba*, of the order *Canellaceæ*. It is also an aromatic.

Nutmegs are the kernel of the fruit of *Myristica fragrans*, of the order *Myristicaceæ*. The nut is within the fleshy fruit, and is surrounded by an arillus or extra covering. This when dried and ground, is known as **Mace**. The tree grows in the East and West Indies, Banda Isles, Sumatra, Brazil, &c. The nutmeg yields 6 per cent of an essential oil of a powerfully aromatic taste. Mace yields $4\frac{1}{2}$ per cent of an aromatic oil.

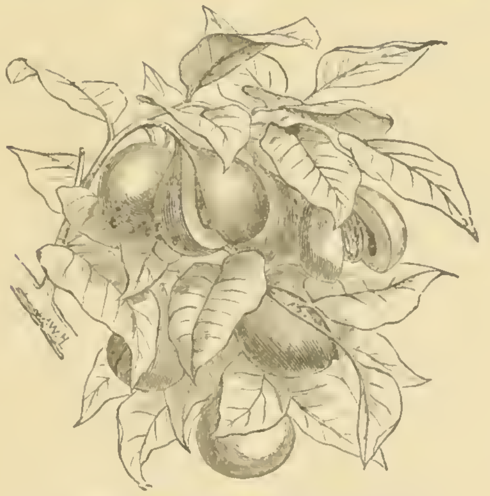

Fig. 246.—Nutmeg (*Myristica moschata*).

Cloves are the dried flower-buds of *Eugenia caryophyllata*, of the myrtle order. It is a handsome evergreen tree, native to the Moluccas, and cultivated in Zanzibar and West Indies. The buds are rich in a volatile oil—oil of cloves—yielded by other parts of the plant also.

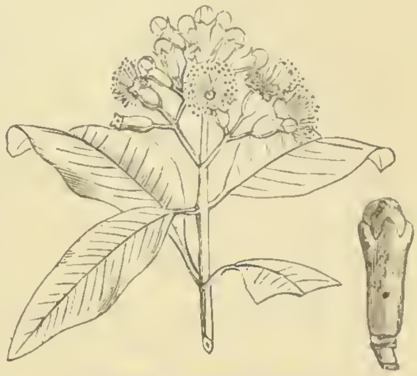

Fig. 247.—The Clove Plant.

Tarragon (*Artemisia dracunculus*) belongs to the *Compositæ* order, native to Siberia, and cultivated in France. Wormwood belongs to the same species; also mugwort and southernwood. In France it is used for flavouring vinegar and salads.

Vanilla, so much used in the form of an essence for flavouring purposes, is derived from the pods of an orchid, specially *Vanilla planifolia*, native to tropical America. It can now be made artificially from pines.

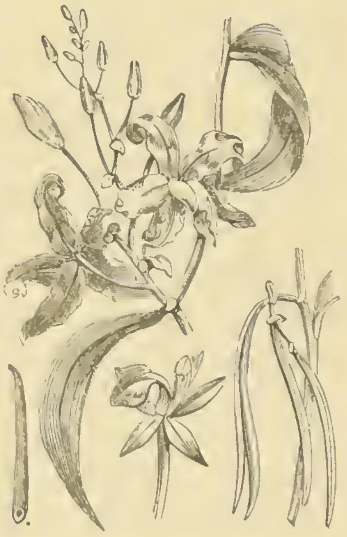

Fig. 248.—Vanilla.

Animal and Vegetable Foods Compared.

It will now be of interest to contrast animal and vegetable foods from the point of view of their nutritive value so far as that is indicated by their chemical composition. This will be best done by taking typical foods representative of each class. The following table shows the composition of various foods, selected from tables already given, and chosen because of their representative character. The water, saline constituents, fibre, &c., have been omitted, and only the percentages of the useful nutritive ingredients given.

Average Percentage Composition of various Animal and Vegetable Foods.

	Lean Beef.	Fowl.	Eggs.	Cows' Milk.	White-fish.	White Bread.	Scotch Oatmeal.	Haricot Beans (dried).	Potato.	Cabbage.	Figs (dried Turkey).	Sago.
Nitrogenous	19·3	22·65	14·0	4·65	18·5	6·82	16·1	20·81	2·3	1·89	6·1	—
Carbo-hydrates (sugar, starch, &c.)	—	—	0·0	4·28	—	52 34	63·0	53·63	19·7	4·87	65·9	80 0
Fat	3·6	3·11	11·0	3·50	3·0	·77	10·1	2·28	0·3	0·20	0·9	—
Totals	22·9	25·76	25·0	12·43	21·5	59·93	**89·2**	**76·72**	22·3	6·96	72·9	80·0

If now, using this table, we reckon up the total nutritive material contained in each of these materials, and, instead of expressing the result in percentages, express it per pound, we get results tabulated in the table that follows.

Total Nutritive Material in 1 lb. of the following Substances:—

Oatmeal	·892	of a lb.,	or fully	14¼	ounces in the lb.
Sago	·800	,,	,,	12¾	,,
Haricot beans	·767	,,	,,	12¼	,,
Figs	·729	,,	,,	11½	,,
White bread	·599	,,	,,	9½	,,
Fowl	·257	,,	,,	$4\frac{1}{10}$	,,
Eggs	·250	,,	or exactly	4	,,
Beef	·229	,,	or fully	3½	,,
Potato	·223	,,	,,	3½	,,
Fish	·215	,,	or barely	3½	,,
Milk	·124	,,	,,	2	,,
Cabbage	·069	,,	,,	$1\frac{1}{10}$	,,

This method of estimating total nutritive ingredients in the pound is not, however, entirely satisfactory, as a glance at the table shows. Oatmeal reigns there pre-eminent, and rightly so. Tested in any way one pleases, it maintains its pre-eminence as the most nourishing food that can be found, as a half more nourishing than white bread, weight for weight, and twice more nourishing than beef. But this method of calculation places sago second in the list, and that pre-eminence is undeserved. It is quite true that one pound of sago contains 12¾ ounces of nutritive material, but that is entirely in the form of starch, no albuminoid material being present, so that, while of great value as an energy-producing food, it is useless for tissue repair. If, then, we separate out the total nutritive material, and estimate how much of it is nitrogenous or albuminoid material, and how much is fat and carbo-hydrate, we shall see at once the relative value of the different foods (1) for tissue growth and repair, and (2) for liberation of energy—fats and carbo-hydrates going together for this purpose. The result is shown in the next tables.

Tissue-forming Material in 1 lb. of the following Substances:—

Fowl	$3\frac{6}{10}$ ounces per lb.
Haricot beans	$3\frac{3}{10}$,,
Beef	3 ,,
Fish	$2\frac{9}{10}$ ounces per lb.
Oatmeal	2½ ,,
Eggs	2¼ ,,
Bread	1 (fully) ounce per lb.
Figs	1 (scarcely) ,,
Milk	¾ (barely) of an oz. per lb.
Potato	$\frac{4}{10}$,, ,,
Cabbage	$\frac{3}{10}$,, ,,
Sago	Nothing.

Energy-yielding Material in 1 lb. of the following Substances:—

Sago	$12\frac{8}{10}$ ounces per lb.
Oatmeal	$11\frac{7}{10}$,,
Figs	$10\frac{7}{10}$,,
Beans	9 (barely) ,,
Bread	8½ ,,
Potato	$3\frac{2}{10}$,,
Eggs	1¾ ,,
Milk	1¼ ,,
Cabbage	$\frac{8}{10}$ of an ounce per lb.
Beef	½ (fully) ,,
Fowl	½ (barely) ,,
Fish	½ ,, ,,

We may observe further that if complete justice were to be done in such a comparison as this, a distinction would require to be drawn between those food-stuffs whose energy-yielding material consisted largely of fat, and those whose energy-yielding material consisted almost exclusively of starch. We have seen (p. 532) that, weight for weight, fat yields fully twice the energy that starch does. Thus the 12¾ ounces of energy-yielding material in sago are all starch, while in oatmeal of the $11\frac{7}{10}$ths energy-yielding substance, $1\frac{6}{10}$ths are fat. Counting the $1\frac{6}{10}$ths fat to be equal to $3\frac{2}{10}$ths starch (and it is fully that), then the oatmeal would contain really $13\frac{2}{10}$ths energy-yielding material as starch, and would thus head the list. In the same way eggs would take a much higher place, because its 1¾ ounces of energy-yielding substance are all fat, equal to something like 4 ounces of starch, or even more. They would thus rank above potatoes, whose energy-containing material is almost exclusively starch. Beef, fowl, &c., would thus also take higher places, because of the 3 to 3½ per cent of fat they contain.

The result of such a comparison is to show that the vegetable foods contain the greatest amount of nourishment in a given weight, and to give them a position as energy-yielding foods to which none of the animal foods can approach, but also to indicate that animal foods possess a value for growth and repair of tissue which excels all vegetable foods, and is only approached by beans (and, of course, foods of the same kind, such as peas and lentils) and oatmeal.

We must not, however, stop at this point. These considerations arise from viewing the chemical composition of the various food-stuffs. We must not forget to consider them from the point of view of the human body, which desires to extract from them this nourishment which they contain; in short, we need to consider the digestibility of the various materials. The result is to modify very materially the position that chemical considerations give to some of the vegetable foods, and notably to beans, peas, &c. In particular, the tissue-repairing material they contain is less readily extracted from them than from most animal foods, and the extraction involves greater waste material to be expelled. When such considerations, and they are detailed on p. 604, are taken into account, the inevitable conclusion is that for the yielding of material for growth and repair of tissues animal foods are unapproached except by oatmeal.

THE ADULTERATIONS OF FOOD-STUFFS, AND UNWHOLESOME FOOD.

Adulteration consists in the addition of some substance foreign to the food-stuff, not acknowledged in its sale and not necessary for its manufacture or preservation. Such substance is usually added to increase the profit on the sale of the article by adding to its weight, such as water injected into beef or added to milk, and plaster of Paris added to flour; or an inferior and cheaper article is added closely resembling the fine quality, such as potato starch to flour or St. Vincent arrow-root, or margarine to butter; or the adulteration is for the purpose of enhancing the appearance of the article sold, such as alum to give whiteness to bread, or copper to brighten the appearance of preserved green vegetables, or colouring matter such as annatto to butter.

The detection of adulteration and its nature are the work of expert chemists, but a few simple domestic methods for some of the best-known articles may be usefully mentioned here.

The detection of the addition of water to milk has been mentioned on p. 551, and to butter on p. 556. The presence of solid matter in milk, such as chalk or starch, to give increased opacity to milk, is detected by the microscope.

Bread. "There is little adulteration of bread," says Wynter Blyth, "save with alum. The long and formidable list of substances supposed to be used by fraudulent bakers, such as sulphate of copper, peas, beans, &c., is drawn from rare instances, or from times of famine, or is based upon theory rather than observation. Bakers' bread in this country, taking it as a whole, is of fair purity and is wholesome. Where the customer is cheated is mainly in weight; here there are really serious and continuous frauds. Notwithstanding inspectors of weights and measures, such frauds are practically unchecked, and only limited by the prudential conscience of the baker." Blyth recommends a ready method of detecting alum in bread, which it will be well to give, as it is of very simple application. "The materials required for the test are a solution or tincture of logwood, to which a sufficient quantity of carbonate of ammonia has been added to render it strongly alkaline, and some slips of gelatin. A slice of the bread is then crumbled into a glass and covered with pure water, a slip of gelatin is added, and the whole allowed to stand overnight. In the morning the swollen and softened slip of gelatin is removed and stained with the ammoniacal logwood. If no alum is present, the gelatin will be of a dark pink or red colour; but if the bread contain alum, the gelatin will be coloured various shades of blue, from a barely-perceptible purple up to quite a decided blue, according to the quantity of alum present." The same solution of logwood simply painted over a piece of suspected bread will indicate by a blue colour if alum be present.

Flour, Arrow-root, Ground Rice, &c., are examined for adulteration by means of the microscope. The starch granules of all these substances are quite peculiar in form, and to one accustomed to the use of the microscope the detection of mixtures, &c., would be comparatively easy. Anyone who wished to examine flour, &c., of various kinds in this way ought first to provide himself with samples of the real article, whose purity was beyond doubt, for the purpose of comparison. He should have a sample of pure wheat starch (Fig. 249), pure potato starch (Fig. 250),

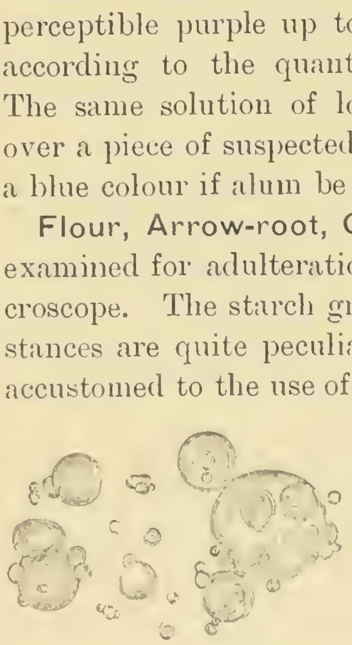
Fig. 249.—Starch Grain—Wheat.

pure Bermuda arrow-root, Canna arrow-root, tous-les-mois (Fig. 251), &c. The differences in the appearances of these different starches are considerable, as the figures show. But careful measurement of the size of the granules is also important, and this can readily be effected by microscopic methods; and finally polarized light is differently affected by different starch grains. A polariscopic apparatus for fitting to a microscope is easily obtained; and thus a complete examination can easily be conducted. By such means the adulteration of flour (Fig. 249) with cheaper potato starch (Fig. 250) is readily detected, and so on; and particles of foreign material, such as sulphate of lime, &c., can also be observed. The flour needs little preparation for examination. A few grains of it, or the arrow-root, or whatever kind of flour it be, are shaken up with a few drops of water in a small clean phial. A drop is placed on the centre of a glass slide and covered with a cover-glass, and then placed on the stage of the microscope. Glycerine is sometimes used instead of water, but it makes the starch granules too transparent.

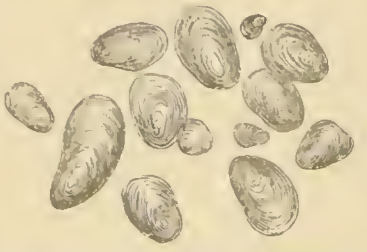
Fig. 250.—Potato Starch Granules.

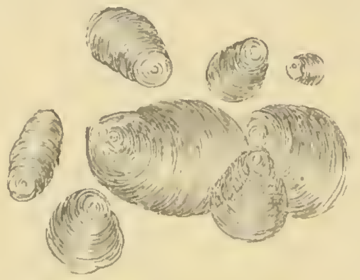
Fig. 251.—Tous-les-mois.

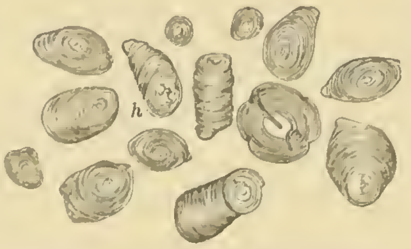

Fig. 252.—Bermuda Arrow-root.

The three accompanying figures (252–254) show the starch grains of three different arrow-roots, the hilum (*h*) in Fig. 252 being slit-like or conical at the large end of the grain, but less distinct in St. Vincent arrow-root, and still less distinct in Port Natal arrow-root. These granules could not be confounded with wheat flour granules (Fig. 249), nor yet with the granules of potato starch. In the latter the hilum is at the small end of the grain, and the granules are much larger. The two following figures show the granules of bean flour and rice flour, sometimes used as adulterants of wheat flour.

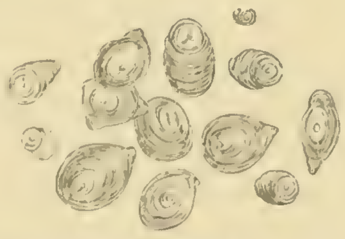
Fig. 253.—St. Vincent Arrow-root.

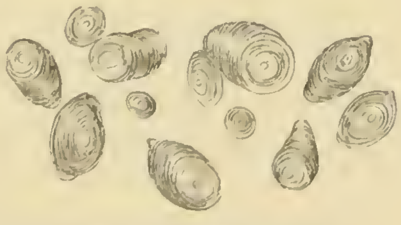
Fig. 254.—Port Natal Arrow-root.

Oatmeal is adulterated with barley-meal, and also with rice and maize; and these adulterations, which, according to Dr. Hassall, are very extensive, may be detected by means of the microscope.

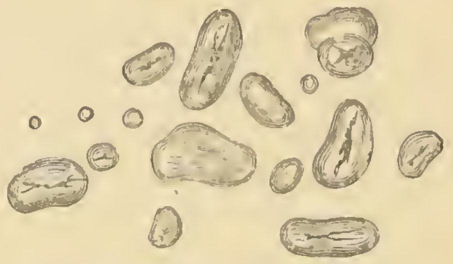
Fig. 255.—Starch Grain—Bean Flour.

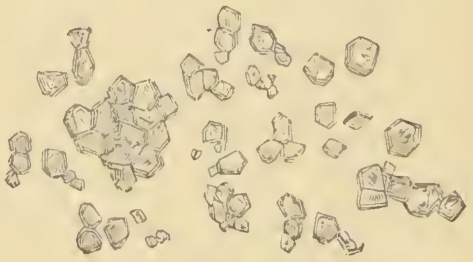
Fig. 256.—Starch Grain—Rice.

Unwholesome Meat.—Good meat, according to Dr. Letheby, possesses the following characters:—1. It is neither of a pale pink colour nor of a deep purple tint, for the former is a sign of disease, and the latter indicates that the animal has not been slaughtered, but has died with the blood in it, or has suffered from acute fever. 2. It has a marbled appearance, from the ramifications of little veins of fat among the muscles. 3. It should be firm and elastic to the touch, and should scarcely moisten the fingers, bad meat being wet, and sodden, and flabby, with the fat looking like jelly or wet parchment. 4. It should have little or no odour, and the odour should not be disagreeable, for diseased meat has a sickly, cadaverous smell, and sometimes a smell of physic. This is very discoverable when the meat is chopped up and drenched with warm water. 5. It should not shrink or waste much in cooking. 6. It should not run to water or become very wet on standing for a day or two, but should, on the contrary, be dry upon the surface. 7. When dried at a temperature of 212° or thereabouts, it should not lose more than 70–74 per cent of its weight, whereas bad meat will often lose as much as 80 per cent. It is also advised to pass a clean knife to the centre of the beef, and smell it after withdrawal, to ascertain if within also the beef is sound.

Very recent observations seem to show that cattle have been long an unsuspected source of disease communication to the people. At Hendon in England and at Glasgow epidemics of scarlet fever seemed undoubtedly to be due to the consumption of milk yielded by cows, suffering from a disease presenting features akin to scarlet fever, as it attacks the human subject. The prevalence of tuberculosis in cattle, and the possibility of tuberculous cattle communicating the disease to human beings, through the medium of the meat of the slaughtered animals, sold for food, have recently occasioned profound anxiety and much discussion among veterinary surgeons. There are perfectly authentic instances on record of meat derived from diseased animals endangering human lives. At the same time there seems no doubt that cattle, which show signs of disease, are regularly slaughtered and sent into market, the owner preferring to do this rather than have the animals dying on his hands. In 1863 Professor Gamgee reported to the privy-council that as much as one-fifth of the common meat of the country was then derived from animals killed in a state of disease. It would, therefore, appear that many of these diseases do not render the meat unsafe for consumption, at any rate after it has been cooked. It is, however, quite possible that, to the eating of such meat is due many simple ailments or states of indisposition, which is not directly attributed to anything in particular. The outbreak of boils and some skin affections have been attributed to the flesh of animals killed when in an unhealthy condition. That there is, nevertheless, great danger in the use of meat obtained from animals suffering from disease of a contagious sort, has undoubtedly been proved. The purchaser has no reliable means of detecting such unwholesome meat. It is only by enlarged powers being given to local authorities, and to thorough and systematic methods of inspection, that this source of danger to the public can be checked.

The presence of parasites in meat, tape-worm of various kinds, and trichinæ, has been referred to at some length on p. 167 and subsequent pages. It is unnecessary to say more on that subject here, unless to call attention to the proof on p. 173 that thorough cooking destroys such parasites, and prevents meat containing them, which has been eaten in ignorance of their presence, from giving rise to any trouble.

Meat in a state of ordinary decomposition is also rightly regarded as unwholesome. Yet it is not nearly universally true that meat becoming decomposed, and even in advanced states of putridity, is hurtful. Game is preferred by the epicure when it is distinctly "high." The North American Indians prefer their meat well advanced in decomposition, and bury it underground to permit it gradually to become so. The Greenlanders treat seal flesh in the same way. Still, meat in a state of decomposition, even slight, is capable of giving rise in many people to severe irritation of the stomach and bowels, acting just like an irritant poison. Putrefaction it has been seen is a very complex process. It is the result of the activity of very many different organisms, each one attacking the meat to derive from it the particular nourishment it needs, and, in the process, producing by-products of peculiar kinds. What we call putrefaction is simply the changes evident to our senses that have been produced, but it is the combined result of many different organisms. It may be that of two pieces of meat, subject to putrefaction, one would be quite harmless, and the other hurtful, though in both the offensive smell, &c., seemed identical, because some particular organism had attacked the one piece and produced in it hurtful materials, not present in the other, whose presence, however, was not discernible by any alteration of odour. For the prevalent view regarding such organisms is that it is not so much the mere presence of the organism that is harmful, but the by-products of their activity. To some of these by-products of the decomposition of albuminous substances the term **ptomaines** has been applied by Professor Selmi of Bologna. It is a remarkable fact that in the course of digestion albuminous foods may yield products hurtful to the person. The fact that some persons cannot eat eggs, mutton, &c., is now partially explained by the view that they are peculiarly susceptible to the influence of certain substances formed during the normal digestion of these foods. The decomposition of fish has been shown to yield a poison, muscarine, which, before that discovery, was derivable only from one of the poisonous mushrooms—*Agaricus muscarius* (see p. 583). From the dead human body various poisons, more or less powerful, have been isolated. A considerable number of cases of sausage poisoning has been recorded, and there have also been several instances of marked symptoms of irritant poisoning after the use of tinned meats. These appear, without doubt, to be due to the presence in the meat of such ptomaines which have been developed as the result of decomposition of some of the albuminous constituents of the meat. It is quite unnecessary to suppose that any poisonous substance has gained entrance, by accident or design, to the meat. Moreover, there is no ordinary test by means of which one could be assured of the wholesomeness or otherwise of the food. The only precaution one can take in buying tinned meats is to notice whether the surface of the tin is hollowed. If it is, one may be sure no decomposition has taken place within, which would be suggested if the tin were to bulge outwards.

Tinned Fruits and Vegetables are not infrequently contaminated by some adulterating agent, added to heighten the natural colour. Thus pickles, olives, green fruit, such as gooseberries, green-gages, and limes, as well as green vegetables, are adulterated with copper, the sulphate of copper, or blue-stone, being usually employed. The quantity of copper present per bottle is said to be as a rule half a grain per bottle. Red fruit—currants, raspberries, cherries—is heightened in colour by decoction of logwood, infusion of beet-root, as well as the red aniline colours. Dr. Hassall states that of 33 samples examined by him, only seven were free from contamination by copper.

To test for copper pour some of the fluid in which the fruit or vegetable is preserved into a tall glass vessel, add three drops of strong nitric acid. Immerse in the fluid for a few hours, a piece of thick, smooth and polished iron wire. If copper be present a fine coating of copper will appear on the wire. If the liquid used is vinegar, as in the case of pickles, it is not necessary to add the nitric acid.

THE DIGESTIBILITY OF FOOD.

In the preceding pages the value of food-stuffs has been considered from the chemical point of view mainly. We have seen that, for the nourishment of the body, substances containing nitrogen in the form of albuminous bodies, such as the white of egg, the casein or curd of milk, the myosin of flesh, the gluten of wheat, and the legumin of peas and beans, and carbon in the form of sugar, starch, and fat, are necessary, and that upon the quantities of such substances contained in the various food-stuffs does their nutritive value depend. But it is very necessary to consider foods from another point of view. These food-stuffs become valuable only when they have passed into and become part of the circulating blood in our bodies. This they cannot do in the condition in which we eat them, hence the elaborate apparatus and process of digestion, described in section VI. in the first part of this work, to fit them for entering and becoming part of the blood. This process requires time and implies the doing of work by the digestive organs—that is to say, the expenditure of energy. Now it is plain that if one substance takes a longer time and more work of the bodily organs to undergo digestion, more energy will have been expended in the process, and, before one could quite accurately judge of its value to the body as food, one would require to deduct from the total nutriment it was calculated to contain, a quantity representing the energy expended in its digestion. So that another substance, containing less nutritive material, might be actually more profitable to the body, because more easily and rapidly digested. The time, therefore, the various food-stuffs require in order to undergo digestion requires to be taken into account in estimating their relative values. In the next place one must consider how far each substance can yield up to the body the nutritive material which chemical analysis shows it to contain, whether it is in such a form, that is to say, as renders it suitable for the action of the digestive fluids rendering it fit to enter the circulation. If the nutritive material it contains cannot readily be extracted from it by the process of digestion, much of it will never really enter the body, but will simply pass through the alimentary canal unchanged, and be finally cast off as waste from the bowels. If the quantity of waste, so cast off after different diets, be measured, a fairly accurate idea of the actual amount of nourishment each diet has supplied to the body will be obtained. In determining the digestibility of foods, then, these two things require to be taken into account, the time required for their digestion, and the actual amount of each rendered available for purposes of nutrition. When these have been ascertained, and when this knowledge is added to that of the chemical composition of the various foods, one has the chief information necessary for the forming of a judgment as to the values of the different foods.

The Time required for Digestion of different substances is our first consideration. There are several ways of acquiring this information. As is indicated in section VI. Part I., the ferments, which are the active agents in digestion, can be separated out from the organs of the body in which they are prepared. The ptyalin of the saliva (p. 143), the pepsin of the stomach juice (p. 143), the pancreatin of the pancreas (p. 145), are readily obtained in quantity. One may take a solution of white of egg, a solution of boiled starch, and so on, place some in a test tube, add to it a small quantity of the digestive ferment, pepsin, pancreatin, &c., and then set it aside in a place kept at the temperature of the body, and note what time elapses before the food-stuff has been completely acted upon by the ferment. Such experiments, made with different substances, under precisely similar conditions, will enable one to determine the relative speed of digestion of the different substances. A unique opportunity of observing the rapidity of digestion in the human subject, under ordinary conditions, was afforded to Dr. William Beaumont, in the person of one Alexis St. Martin, a Canadian, who had a permanent opening into the stomach through the skin, owing to a gunshot wound. Dr. Beaumont was able to introduce substances into the stomach through the opening and observe the rate of digestion. More recent experiments have been made in German laboratories, where students, laboratory attendants and others, willingly lent themselves for the purposes of observation, by taking food into an empty stomach, and, after varying times, allowing it to be withdrawn by a stomach-pump, so that the extent to which it had been acted upon might be determined. In various other ways much knowledge has been obtained.

The following list from Beaumont indicates the time of digestion *in the stomach* of various animal foods:—

Name of Food.	How Cooked.	Time.
Pigs' Feet (pickled),	Boiled	1 hour.
Tripe (pickled),	,,	1 ,,
Eggs (whipped),	Raw	1½ hours.
Salmon Trout (fresh),	Boiled	1½ ,,
Barley Soup,	,,	1½ ,,
Venison Steak,	Broiled	1 hour 35 min.
Milk,	Boiled	2 hours.
Beef Liver,	Broiled	2 ,,
Eggs,	Raw	2 ,,
Cod (cured, dry),	Boiled	2 ,,
Milk,	Raw	2 ,, 15 min.
Turkey Eggs,	Boiled	2 ,, 25 ,,
Turkey,	Roasted	2 ,, 30 ,,
Sucking Pig,	,,	2 ,, 30 ,,
Lamb,	Broiled	2 ,, 30 ,,
Meat and Vegetable Hash,	Warmed	2 ,, 30 ,,
Chicken,	Fricassed	2 ,, 45 ,,
Custard,	Baked	2 ,, 45 ,,
Beef,	Boiled	2 ,, 45 ,,
Oysters,	Raw	2 ,, 55 ,,
Eggs,	Soft boiled	3 ,,
Beef-steak,	Grilled	3 ,,
Mutton,	Boiled	3 ,,
Bean Soup,	,,	3 ,,
Chicken Soup,	,,	3 ,,
Oysters,	Roasted	3 ,, 15 min.
Pork Steak,	Grilled	3 ,, 15 ,,
Flounder,	Fried	3 ,, 30 ,,
Butter,	Melted	3 ,, 30 ,,
Cheese (old strong),	Raw	3 ,, 30 ,,
Mutton Soup,	Boiled	3 hours 30 min.
Eggs,	Hard boiled	3 ,, 30 ,,
Salmon (salted),	Boiled	4 ,,
Fowls,	,,	4 ,,
Soup, Beef, Vegetables, and Bread,	,,	4 ,,
Heart,	Fried	4 ,,
Marrow Bone Soup,	Boiled	4 ,, 15 min.
Pork (recently salted),	,,	4 ,, 30 ,,
Veal,	Fried	4 ,, 30 ,,
Wild Duck,	Roasted	4 ,, 30 ,,
Mutton Suet,	Boiled	4 ,, 30 ,,
Pork,	Roasted	5 ,, 15 ,,
Beef Suet,	Boiled	5 ,, 30 ,,

The time of digestion of vegetable foods is shown in the next table:—

Name of Food.	How Cooked.	Time.
Rice,	Boiled	1 hour.
Apples (sweet mellow),	Raw	1 ,, 30 min.
Sago,	Boiled	1 ,, 45 ,,
Tapioca,	,,	2 hours.
Barley,	,,	2 ,,
Apples (sour),	Raw	2 ,,
Pod Beans,	Boiled	2 ,, 30 min.
Parsnips,	,,	2 ,, 30 ,,
Potatoes (Irish),	Roasted	2 ,, 30 ,,
Cabbage (head),	Raw	2 ,, 30 ,,
Apple Dumpling,	Boiled	3 ,,
Corn Cake,	Baked	3 ,,
Corn Bread,	,,	3 ,, 15 min.
Carrots,	Boiled	3 ,, 15 ,,
Bread (wheat, fresh),	Baked	3 ,, 30 ,,
Turnips,	Boiled	3 ,, 30 ,,
Potatoes (Irish),	,,	3 ,, 30 ,,
Green Corn and Beans,	,,	3 ,, 45 ,,
Beets,	,,	3 ,, 45 ,,
Cabbage,	,,	4 ,,

The times given in these tables are the mean times in the case of the particular individual experimented on, and are not to be taken as absolute, though they fairly indicate the relative digestibility in time of the different substances. In the case of that one individual the time required for digesting the same substances varied on different days with varying conditions of the person himself, and with varying external conditions also. Thus the rapidity varied with the quantity eaten. A full meal was digested even more readily than a small and insufficient one, though, as one would expect, excess of food slowed the process. The rapidity varied also with the nature and amount of previous exercise, and with the interval since the preceding meal. After prolonged and exhaustive exercise the digestive organs share in the general depression, and food ought not to be immediately taken; while, if too short an interval has elapsed since the last meal, the next one finds the stomach unprepared to receive it. In the case of St. Martin the state of the weather was found to affect the rapidity of digestion. Active exercise immediately *after* a full meal tends also seriously to interfere with the digestive process, and even to arrest it. If the meal has been small, moderate exercise facilitates its digestion, and moderate exercise is also of advantage some time, an hour or so, after a full meal.

Somewhat conflicting views are held as to the influence of sleep after a meal, many maintaining that the after-dinner nap, customary with many people, interferes with the rapidity of digestion. It is unwise to lay down hard and fast rules. It is an undoubted fact that a sleep after dinner is useful to many, though it may be injurious to others. It may be said with some confidence that a sound and prolonged sleep is hurtful, because in sleep the activity of the vital processes is diminished, and this, lasting for any time, would undoubtedly retard digestion. It may be taken as a general rule that after a full meal, such as dinner, it is better to pass an hour or more in pleasant conversation, or some similarly light occupation, before any active work is engaged in. After lighter meals, such as lunch, tea, &c., no such interval is required.

Dr. Beaumont found that cold drinks introduced into the stomach in any quantity during digestion had a markedly slowing influence upon the process. A single gill of water at 50°, introduced on one occasion, lowered the temperature within the stomach to 30°, and its natural heat was not restored for half an hour. Drinking iced water, or cold fluids in any quantity, eating of ices after meals, &c., are therefore not to be encouraged.

One extremely important factor in the rapidity of digestion of solid food is the degree to which it has been broken down by chewing. If the food be imperfectly chewed, it remains in large pieces, and the gastric juice cannot penetrate to the interior of the masses; whereas if the food has been broken up into minute portions, they are all attacked at once, and digestion is rapidly completed. Probably this supplies the reason of the greater rapidity of digestion of boiled over unboiled milk. In the process of digestion milk curdles, the curd forming masses of considerable size, which take some time before they are broken down by the gastric juice. If the milk has been boiled, the curd formed is in much smaller masses, and hence the greater ease in digestion.

As regards the actual time taken by some of the substances, the above table will occasion some surprise by the length of time assigned to soup for its digestion. Barley soup digested in 1½ hours, but bean soup and chicken soup took as long, 3 hours, as grilled beef-steak and boiled mutton, while mutton soup took half an hour more, and bone soup 1¼ hours longer. Contrary to one's expectation soups and fluid diet are not more easily digested than solid nutriment. This is confirmed by the experience of invalids, convalescents, and dyspeptic persons, who very frequently prefer a solid or semi-solid diet to the beef-teas and chicken broths which are the popular diets for them. Dr. Beaumont says that "solid food is sooner disposed of by the stomach than fluid, and its nutritive principles are sooner carried into the circulation." It has been observed, however, that the exhaustion from abstinence is more quickly removed by liquid than by solid nourishment. On the whole animal food, when suitably cooked, is more easily digested than vegetable food, in particular than green vegetables.

The Influence of Cooking on the Rapidity of Digestion is well shown in the tables that have been given.

Raw whipped Eggs	digested in	1½	hours.	
Raw Eggs (ordinary)	,,	2	,,	
Soft boiled Eggs	,,	3	,,	
Hard ,,	,,	3	,,	30 min.

The whipped eggs were digested most readily, because by the whipping process the egg was worked up into a froth, that is, the egg was separated up into minute particles by the switching in of air, and the digestive fluids attacked it most easily. The heating process coagulates or clots the chief constituent of the egg, and renders it no longer soluble in water. The longer it is boiled the more insoluble it becomes, and the longer is its period of digestion. This is worthy of noting, because a similar change is produced in the albuminous substances of butchers' meat by cooking. If the meat is subject for any length of time to a heat as great as that of boiling water, all its albuminous material becomes changed into the insoluble form, and its readiness of digestion is consequently much diminished. This is very well shown in the case of experiments performed by Jessen, at Tübingen. The subject of the experiments was a laboratory attendant. He took meat, raw or cooked in various ways, and after the lapse of varying times allowed it to be withdrawn by means of a stomach pump to determine the rapidity of digestion. The different kinds of meat were all taken on an empty stomach, so that no disturbance could arise by the presence of other foods. In this case the following were the results:—

Raw Beef digested in	... ...	2 hours.
Boiled Beef (half done) digested in		2½ ,,
Boiled Beef (well done)	,,	3 ,,
Roasted Beef (half done)	,,	3 ,,
Roasted Beef (well done)	,,	4 ,,
Raw Mutton digested in	...	2 ,,
Raw Veal	,, ...	2½ ,,
Raw Pork	,, ...	3 ,,

This shows that the more thoroughly meat is cooked, the longer is the time required for its digestion. Raw or half-raw meat is therefore preferable to well done meat. But then there arises the risk of being supplied with meat containing the eggs of intestinal worms (see p. 167), which thorough cooking would render harmless (see p. 173). Vegetable foods, however, require cooking for their digestion, and thorough cooking. The cellulose, which envelops starch grains and invests vegetable cells, is not soluble in the digestive fluids. By the process of cooking it is ruptured, and the contents of the cellulose envelope are therefore allowed to come into contact with the digestive juices.

Aids to Digestion in the shape of condiments, mustard, pepper, and alcoholic stimulants are much in use for accelerating the digestive process. Experimental physiology offers a few results in the direction of justifying an opinion on this subject also. It appears from sundry experiments that, in health, these adjuncts are not necessary. In one or two of the trials all flavouring materials were removed from the food before it was given. It was thus rendered tasteless and insipid, and was eaten without relish, indeed with distaste and almost repugnance, by the person, and yet its digestion was not impeded. In the case of the healthy, therefore, only the milder kinds of flavourers or appetizers ought to be used. On the other hand, in the case of those of small appetite or feeble digestion, there is no doubt such appetizers are valuable, not only because of the fillip which they give to the appetite, but also because, by their stimulating action on the mucous membrane of the alimentary canal, they excite increased flow of blood to the part, and increased secretion of digestive juices, with consequent increase of the digestive capacity. But the risk of healthy persons, who need no such goads to digestive activity, employing such agents, from liking, to excess, ought to be guarded against. If the stomach is accustomed to pronounced exciting to its work, by and by it will refuse to act till the stimulus is applied.

The Influence of Tea, Coffee, Whisky, &c., on the Time of Digestion has recently been studied by Sir Wm. Roberts of Manchester. He carried out his observations by means of test-tubes containing, some of them solutions of starch, others of them morsels of beef, &c. To these he added the digestive ferment, and observed how long the process occupied in the test-tube, kept at a proper temperature. To a test-tube with exactly the same ingredients, he added a definite quantity of infusion of tea, or coffee, or whisky, &c., as the case might be, and contrasted the rapidity in this case with that of the preceding.

In the case of the digestion of starch he found that a 5-per-cent infusion of tea arrested starch digestion when it amounted to 10°/o of the total contents of the test-tube. That is to say, if the contents of the test-tube consisted of tea infusion to the extent of a tenth, digestion stopped. Even if the tea infusion was only a hundredth part of the contents of the test-tube, the digestion of the starch was slowed. *This injurious effect of tea, Roberts found, was prevented if* 10 *grains of bicarbonate of soda* (*the quantity that can be taken up on a threepenny piece*) *were added to each* 10 *ounces* (*that is half a pint, or a breakfast-cupful*) *of tea.* Coffee had not the same effect to the same extent, for double the quantity of a 5-per-cent infusion of coffee did not affect the action on the starch to the same extent.

The digestion of starch was slowed by 10 per cent, and quite stopped by 20 per cent of French brandy, while it took twice the quantity of Scotch whisky to produce the same effect. This action was due not to the spirit, but to the ethers and volatile oils contained in the brandy and whisky, and more in the former than the latter. In the case of wine 1 per cent was sufficient to arrest digestion, because of the acidity of the wine. If to sherry or port something be added to counteract the acidity, such as effervescing soda, potash, or seltzer water, or Apollinaris, the slowing action is prevented. Simple aerated water will not do: it must contain some alkali, like soda or potash, in solution.

Roberts extended his experiments to digestion as carried on in the stomach, and found similar results. Tea and coffee both seriously delay digestion there, and so also does cocoa, though not to the same extent as either of the former. Twenty per cent of a 5-per-cent infusion of either tea or coffee seriously slowed the process, while a quantity equal to ten per cent had a perceptible effect.

In the case of alcoholic liquors it was found that, if the total amount added to the food was not sufficient to make the quantity of proof spirit more than equal to a tenth of the total bulk of the food, no retarding effect was observed; when the quantity reached 20 per cent—was a fifth, that is to say, of the total bulk of the food—the slowing effect was slight; and when it reached 40 per cent almost no digestion occurred. Roberts estimated that if the total quantity of food taken into the stomach at a meal weighed 2 lbs., then 2 ounces of brandy or whisky—that is, less than a wine-glassful—would equal five per cent, and would not impede digestion. But if the quantity of spirit were increased, the delay of digestion would set in, in proportion to the quantity of alcohol above the 2 ounces taken. Sherry slows digestion to an extent out of all proportion to the spirit it contains, a quantity equal to a fifth of the total bulk of food taken making the time needful for digestion three times longer than it ought to be; while double that quantity altogether stopped it. Sparkling wines were less injurious than still wines. Malt liquors also impede the process, and, like wines, to an extent quite out of proportion to the contained spirit. When the malt liquor reached to 40 per cent of the bulk of the food, the deterrent action was very marked. If, then, malt liquors, such as stout, are taken with dinner for the sake of their stimulating effects, specially in the case of invalids, a much smaller quantity than the customary pint bottle yields should be used. It will very frequently be found that a third of that amount is useful without impeding digestion. Hence the value of the ½-pint bottles now coming into use for the various kinds of nourishing or "invalid stout," as it is called.

The Quantity of each Food-stuff extracted in the body for purposes of nutrition must next be considered. This is determined by weighing the quantity of food eaten, and then weighing the waste cast off from the bowel. The difference represents the amount of food retained in the body for use. Though two foods contain the same amount of nutritive materials, but one of them invariably yields more waste, it is evident that that one is of less value; it is, that is to say, less digestible. A considerable number of experiments has been made in this direction, chiefly in German laboratories; and the results are summarized in the following table. In each case the calculation is made for 100 parts of the food-stuff, and in one column is shown the proportion of that retained in the body, and in the other the proportion expelled as waste.

Name of Food.	Proportion Used in Body.	Quantity Expelled.
Sugar, ...	100	0
Butter, ...	98	2
Oleo-margarin, ...	96	4
Rice, ...	96	4
Fish, ...	95·1	4·9
Maccaroni, ...	95·7	4·3
Roast Beef, ...	94·8	5·2
Hard-boiled Eggs, ...	94·8	5·2
White Bread, ...	94·4	5·6
Milk and Cheese (in proportions of 11 of former to 1 of latter), ...	94	6
Indian Corn, ...	93·3	6·7
Milk and Cheese (9½ to 1), ...	93·2	6·8
Cow's Milk, ...	91	9
Pease Meal, ...	90·9	9·1
Potatoes, ...	90·6	9·4
Rye Bread, ...	89·9	10·1
Milk and Cheese (2 to 1), ...	88·7	11·3
Cabbage, ...	85·1	14·9
Coarse black Rye Bread, ...	85	15
Carrots, ...	79·3	20·7

Putting sugar and butter aside as being used only as adjuncts to food, we find that rice, meat, and eggs (and fish is included with meat) head the list of digestible articles, practically yielding up almost all the nutriment they contain to the body. Of bread it is interesting to note that the quantity of nutriment extracted depends on the fineness of the flour. Thus rye bread is far behind white bread, and the coarse black bread still further. We have here an illustration of the fact commented on on p. 560, that though the branny portions of the wheat-grain contain more tissue-forming material than the white kernel, their addition to the flour to any extent does not make the bread more valuable, both because these coarser particles are less digestible and because they so stimulate the bowel as to hurry the material too fast along the alimentary canal. As regards milk it is very interesting to observe that there is less waste on an exclusively milk diet in the case of the infant than in the case of the adult. Thus in the case of a child, observed for 11 days, 6·35 per cent of the dry solids of the milk were expelled daily from the bowel, while in the case of the adult the amount varied from 7·8 per cent to 10·2 per cent. This is another proof of what has already been said on p. 542, that as an exclusive diet milk is more suited for the growing than for the full-grown person. In the adult a considerable proportion of the waste consists of the mineral constituents of the milk, particularly the lime salts, which the child retains for the formation of bone. In short, cow's milk is not so advantageous a diet for the adult as meat or egg. The experiments made with milk and cheese were so performed because cheese could not be made an exclusive diet. It may seem remarkable that milk with a small proportion of cheese should be more completely made use of than milk alone. The reason seems to be that milk alone forms large masses of curd in the stomach, in process of digestion, which the gastric juice cannot quickly attack, while, if cheese has been eaten, the small particles prevent the curd forming in such masses, and permit of the gastric juice attacking a large number of smaller portions of curd at the same time. If the proportion of cheese rises unduly, then it is not so completely digested. Then it is to be noted how much more digestible the animal foods are than those vegetable foods which are rich in proteids or tissue-forming materials, such as peas, beans, &c. If animal food is to be entirely replaced by vegetable food, it must be by such foods as peas, beans, and lentils, for these only contain a rich supply of the needful proteid. The table shows that such replacement would not be economical of the energy of the body. As regards fat, though the table is silent on that point, it appears that animal fat is more digestible than vegetable fat, and more easily assimilated.

Such considerations do not countenance the use of vegetable foods to the exclusion of animal foods. They rather support the view that an appropriate mixture of the two kinds of food-stuffs will most readily yield the desired quantity of nutriment to the body, with the greatest economy of bodily energy, and corroborate the position taken up in the early part of this section, that, for growth and repair of tissues, material is most readily and abundantly yielded by animal foods, and for yielding of energy for the maintenance of heat and the doing of work the material is most easily obtained from the vegetable kingdom.

THE PRINCIPLES OF COOKING.

Why do we cook? is a question which would probably puzzle a great many people who pride themselves on their skill in the art of cookery, but it is a question on which really depends the answer to the other question, *How* should we cook? Probably, in the first instance, the object of cookery is to please the palate, so that eating shall not be simply a necessity of continued existence, but also an ever-recurring source of pleasure and gratification. But a second and very important object in cooking is to render the food to be eaten more readily digestible. The immediate purpose of eating is to satisfy the demand for material for the upkeep of bodily strength and vigour, and it is evident that the success of cookery and its methods are to be judged by the extent to which it aids that purpose and adds pleasure to it, while any method is self-condemned which renders the task of extracting the nutriment from the food more difficult for the body, even though it, at the same time, adds greater pleasure to the taste. These two main objects of cooking are of very great importance for all classes of the population. There is far too great a tendency to regard what is called, with some suspicion of a sneer, the "gratification of the palate" as an object which can only be followed by the moderately "well-to-do people," and as a consideration which the poorer of the community cannot afford to regard. As an absolute matter of fact it is a subject of more importance to those of limited means than to those of large resources. It has been shown that the flavour of a meal has not any influence on its digestion in the case of a healthy man. But the same experiments which proved this proved also that the absence of flavour was a serious hindrance to the taking of a proper quantity of food. Thus Prof. Forster observes that in the case of one man, on whom he experimented, meat from which the flavour had been removed was so tasteless as to be eaten in any considerable quantity only with difficulty, and yet the quantity digested and passed into the circulation was as large as with the same meat roasted in the ordinary way; and in other experiments with a mixed diet, from which also the flavour was removed, the diet became, when continued, so repugnant that great effort was required to eat it, while, nevertheless, the digestion was unaffected. Now in the case of those with limited means the diet is apt to be, indeed is certain to be, much more restricted in variety, and its sameness will in time produce something of the same aversion. In such cases the art of cookery has greater scope, and becomes of infinite value by the variety it may introduce without additional expense, and its benefits will be far more marked than in the case of those whose means permit of a greater variety of food-stuffs. The poorer classes have, indeed, more need of knowledge being put within their reach of the method of gratifying the palate by the art of cooking than the richer classes. There can be little doubt that the temptation among the working-classes to the frequent use of stimulants is greatly strengthened by the lack of variety and excitement in the food habitually served up to them, and that the introduction among them of better and more extensive methods of cooking would have a direct and powerful effect in the promotion of temperance. It would also add to their material resources by showing them how simple and inexpensive articles, remnants of former meals, and so on, might be dressed up in agreeable and appetizing and satisfying forms. For it has been shown by actual statistics that there is no class of the population which buys so expensive kinds of food—the richest cuts of beef, for example—all to obtain the richness and strength, which they think is associated with the fuller flavour, and which they might confer on the food more cheaply by modes of preparation.

Cooking has very different effects on animal food from those it produces on vegetable food. It has been shown in the preceding article that, as a rule, animal food is considerably more digestible in the raw than in the prepared state, while the chief vegetable foods, such as bread, oatmeal, rice, corn-flour, green vegetables, &c., are made digestible only by sufficient cooking. On the other hand the flavour of both is largely the result of the method of preparation. In the case of animal foods, in particular, the question thus comes to be, How may it be cooked so as to develop its finest flavour, without unduly diminishing its digestibility?

Let us take, as an example, a piece of beef or mutton. The nutritive material it contains is chiefly the proteid or albuminous constituent, which forms the chief part of the red flesh. This is largely soluble in cold water, and is in that form easily digested. But by water near to the boiling point, or by heat to the same degree, however applied, it is coagulated and rendered insoluble and less easily digested, and the greater the heat and the longer it is applied the more solid becomes the coagulated mass, and the more difficult does it become of digestion. The connective tissues or fibrous portions which bind the red flesh together, and also form the tendinous parts, are converted into gelatine by boiling, and are rendered more easily broken down, so that the mass of meat can be more easily broken down into particles, can be more easily chewed, and therefore more readily prepared for the action of the digestive juices. To this extent, therefore, cooking will aid the digestion of animal food. The flavouring materials, the extractives of the meat, are dissolved by water, and in process of cooking with water may readily be dissolved out to a large extent, rendering the meat more or less tasteless. Moreover the action of the heat develops flavouring substances in the meat not existing in it previously as such. The nature and extent of these sapid substances entirely depend upon the manner in which the heat is applied. They are specially developed by a dry heat, as applied in roasting, and it is owing to their production that roast beef is so much more full in flavour than beef cooked otherwise. It appears, then, that the cooking of a leg of mutton is a much more complicated problem than many people suppose. For the desire is (1) to apply the heat long enough to heat it equally throughout, and to render it as tender and easily masticated as possible, (2) to guard against extracting from it any of the flavouring materials it already possesses, (3) to develop as much as possible new flavouring substances, and withal (4) to avoid so great a degree of heat, or so long continued an application, as would harden the flesh and render it difficult of digestion. These are the different points to secure which a cook really aims, when a leg of mutton or a roast of beef is set him to prepare, whether he would express them in so many words or not, and they clearly indicate a particular method to be adopted.

But now suppose the same cook has a piece of beef or mutton set before him for the making of soup. His object is now very different; it is no longer to retain in the meat as much of its flavouring materials and juices as possible, but to extract them, and to get as much of them as he can into the surrounding water; and his method must be correspondingly different. If one clearly realizes to one's self the difference between these two processes, and the difference of method they imply, then one shall have laid a sure foundation for the practice of cookery; but every one who has not realized them is ignorant of the very A B C of the science. Let us consider the two cases.

To extract the juices of meat is easy enough, unfortunately too easy, many people will say, and too often done. All one requires to do is to steep the beef in cold water, and, particularly if it has been broken down into small pieces, all of its flavouring material and a considerable quantity of its nourishing material will become dissolved in the water. But how to retain the juices in the meat is the problem. Suppose the leg of mutton to be plunged into boiling water, what will happen? Almost immediately the albuminous portions of the meat in contact with the boiling water will become insoluble, will coagulate, and if the meat be exposed to this heat for a short time only, it will have become completely surrounded by a film of coagulated material, the heat not having had time to penetrate far in—will have become sealed up as it were; and if the mutton were now placed in cold water, this coagulated film, being insoluble, would oppose the passage outwards of the juices of the meat. If the meat were kept in the boiling water the heat would gradually penetrate inwards, coagulating and hardening as it proceeded, the outer parts becoming always harder and drier because of the prolonged action of the high temperature. But if, after the meat has been two or three minutes in the boiling water, the heat of the water is allowed to fall considerably, then a film of coagulated albumin will have formed outside sufficient to retain the juices of the meat, and the cooking can be proceeded with at a lower temperature and a longer period without risk to juiciness and tenderness. Exactly the same principles are applicable in roasting or baking meat. One desires to cook the meat throughout to a certain degree, but to retain all the juice within it. If it is exposed suddenly, and all round, to the full influence of a bright clear fire, a film of coagulated albumin is formed, sealing up the juices; then the meat is withdrawn from its close proximity to the fire, or if it be in an oven the heat of the oven is allowed to fall, and cooking gradually proceeded with.

Boiling, roasting, baking, broiling and frying are the chief ordinary operations in the preparation of food, and these may now be briefly noticed in detail.

Boiling. What has been already said in general is specially applicable to boiling. In boiling the heat is communicated to the meat by the agency of water, and, except in the production of soups and beef-teas, and the like, one desires to convey as little as possible of the material of the meat to the medium of communicating the heat. To cook meat by this means, therefore, which is to be served up at table, the water should be boiling, the meat plunged into it, there being sufficient water completely to cover the meat, and the pot should be kept on the fire till the water again boils. The introduction of the meat will have put it "off the boil" for a few minutes. When the water has boiled again for two or three minutes, not more, the pot should be removed to the side of the fire, so that the temperature of the water is reduced to below even the simmering point. If one were to gauge the temperature by means of a thermometer, it would be not more than 180° Fahr., or between that and 160° Fahr. (boiling point is 212°). At this heat it should be kept till the central parts of the meat have had time to be heated to the same degree. The time necessary will depend, of course, on the size of the piece of meat, and it will be longer than if the boiling temperature were maintained; but the reward of the longer period is juicy meat, tender, and with its fibres soft and readily separated from one another, not firm, tough, and shrunken. In thus cooking meat a fork should never be plunged into it to see if it is sufficiently done, for this would break the sealing and open a way of escape for the retained juices. Meat when thus properly cooked is easily recognized at table by the rush of juice as soon as it is cut.

Fish should always be boiled in this way, with skin as unbroken as possible; and their flavour is still better obtained if the water used is hard, if sea-water is used, or if some salt is added to fresh water.

In the case of eggs the same method produces excellent results. They are commonly kept in boiling water for three minutes or so. The white becomes exceedingly firm and indigestible, specially next the shell, and often the yolk is unaffected. Now if the eggs be plunged into boiling water and immediately removed from the fire altogether, but allowed to remain covered up in the water for ten minutes, the white will not be hardened, but nicely jellied, and the yolk just set. This is the condition in which eggs should be eaten. This is called "coddling eggs;" and while it may be done in a small covered pan, it may also be done on the breakfast table by means of an appropriate vessel. A tin vessel is obtained so deep that when half full of water an egg would be completely immersed. It may be made of any diameter one pleases, according to the number of eggs one may have to cook in it. It should have a tight-fitting lid, and should be embedded in a "cosy" made for it. A cover should also be made for the lid, so that the whole vessel is surrounded by a cosy. The boiling water is poured into the pan, ½ pint for 1 egg, ¾ths of a pint for 2 eggs, and 1 pint for 3 eggs, and the eggs immediately placed in the water, the lid secured, and the whole covered up. This can lie on the table, and the water and eggs are introduced 10 minutes before the breakfast is served. If a few minutes' delay occurs the eggs are not overdone, and they are kept hot for a long time.

For the production of broth, and when it is desirable to extract all the possible ingredients of the meat, a high temperature is not necessary at any time. The meat should be reduced to small pieces, placed in cold water for some time, slowly heated, but never to the boiling point, for even before that high temperature is reached the albuminous constituents which have become extracted will be coagulated and separated out, but will remain in solution if a lower temperature is maintained. When it is desired to produce stock from tendinous meat, such as hough or joints of bone, prolonged boiling is necessary for the extraction of gelatine, which is derived from tendons, gristle, &c., by boiling.

The flesh of young animals, veal and lamb, does not stand boiling well, because of the large amount of gelatine-yielding substance present, the dissolving out of which makes the meat fall to pieces.

Boiling is the method of preparation most suitable for invalids and those of weak digestion, but it develops the flavour of meat much less than either roasting or stewing, and is not so much enjoyed. Boiled meat is more easy of digestion than that cooked in any other way (see p. 603).

Roasting has already been referred to. The meat ought at first to be brought close to a bright clear fire till the surface is coagulated to retain the juices, then it ought to be withdrawn to such a distance that the heat can never rise above 180°, and it is then allowed gradually to cook throughout. The dry heat causes a considerable loss by evaporation of water, and, to prevent this going on unduly, basting is resorted to by the use of melted butter or the dripping caught in the pan. Not only does this prevent drying but it aids the browning of the outside of the meat, and it is by this browning that the peculiarly acceptable flavour of roast meat is produced.

While roast meat is not so digestible as boiled, it is more acceptable as a rule, because of the increased flavour, and next to boiling, it is most suitable for invalids and dyspeptics. The fat of the meat undergoes some amount of chemical change because of the prolonged action of the heat, and fatty acids are produced which are the chief cause of some tendency to disagree with persons of weak digestion.

Broiling or **Grilling** is practically the same as roasting in its effects. The cooking on the grill is done with great rapidity, a hot clear fire being necessary. The grill being brought close to the fire at first and rapidly turned, the whole surface of the meat is sealed. The grill is then removed to a little distance, and the interior portion of the meat is done more slowly, being cooked in its own juices, as it were, within the outer crust that has been formed. This is an excellent method, when well done, for cooking a chop or steak, and produces a very savoury dish, little less digestible than by boiling.

Baking is pretty much the same as roasting, but being done in the confined space of the oven, partly by hot air, there is less of the material of the meat driven off as vapour in the process. Consequently the flavour produced is much richer and fuller than in roasting. On that account baked meats are much less digestible than roasted, and had better be avoided altogether by the dyspeptic.

Frying is an excellent but much-abused method of cooking. The common method of frying is by the use of the ordinary shallow frying-pan, and the meat is kept from sticking to the pan and burning by some melted butter, lard, or dripping. Now this suits well enough for meat cut in very thin slices such as ham, which can be kept fairly well covered with the liquid fat, or for eggs or omelettes, but is entirely unsuited for other kinds of meat. What is properly meant by frying is cooking in oil, in which the oil is made the vehicle for communicating the heat to the meat, just as water is the vehicle in the case of boiling. This requires a deeper vessel than the ordinary frying-pan, capable of holding such a quantity of fat as will permit of the meat being completely immersed. Now fat boils at a temperature very much higher than water, indeed cannot be boiled in an open pan at all, so that long before its boiling point is reached the temperature of the liquid fat is far above the highest temperature obtainable with water, namely, 212°. Lard is commonly used, and when it is put into the pan and kept on the fire for some time the liquid fat bubbles and crackles as if it were boiling. By and by it becomes quiet. It has not been boiling: it has reached the temperature of boiling water, and then any water contained in the fat is driven off as steam, causing the commotion. When all the water has been evaporated the surface of the liquid becomes still, and the temperature of the fat is then considerably above 212°. Its temperature continues to rise, and soon if bread crumbs be dropped into the fat they at once become browned. At this stage the meat may be introduced. The cutlet or chop is usually covered first with a coating or batter of switched eggs and bread crumbs, and then dropped into the oil, so as to be completely covered by it. If the fat is sufficiently hot the chop or cutlet is cooked in about 10 minutes, very equally throughout, and the coating has acquired a delicate brown with a crisp feeling and pleasant flavour. The hot oil in contact with the outside of the meat has coagulated the albumin, the continuance of the heat has raised the interior of the meat to the boiling point, and it is cooked by the heat of its own juice. Above the boiling point the heat of the meat cannot rise so long as it contains any juice, and the juices are retained. The result is that if the time be properly gauged the meat is well cooked, juicy and tender. The spitting and hissing noise produced when the meat is introduced is due to the explosion of little globules of steam, produced by contact with the hot oil. Further, owing to the very heat the oil is prevented passing into the meat, and when it has been removed and the surface oil allowed to run off, no trace of fat is left. Now this is not an expensive method of cooking, for there is actually less fat used than with the ordinary frying-pan. The fat is readily purified for use again by pouring it, still hot, into a vessel of water. The impurities sink into the water; the fat floating, is easily removed when cold. Besides pure lard, cotton-seed oil (p. 591) may be used. It is, when obtained pure, an excellent oil for the purpose, of very agreeable and delicate flavour, and has the advantage of being much cheaper than lard. This is the only proper method of frying; and when chops, cutlets, and fish are so cooked they are not only pleasant in flavour but also not difficult of digestion. The ordinary shallow frying-pan, on the other hand, is destructive to the meat cooked in it. The meat is really dried, hardened, and shrivelled, and its digestibility very seriously impaired. The use of such a pan ought to be limited to the cooking of omelettes, pancakes, and such like.

Stewing is a process whose object is entirely different from that of the methods already described. Little or no water is added to the meat in the stew-pan. *The meat is never raised to the boiling temperature.* The juice of the meat is thus allowed to exude, and additional liquid is obtained from the various herbs, vegetables, &c., mixed with the meat. A rich full-flavoured gravy is thus obtained in which the meat becomes cooked. Now in the ordinary stew-pan the difficulty of keeping the heat at a proper level is very great, because the meat is directly in contact with the vessel on the fire. As a result a boiling, or, what is next to it, a simmering temperature, is communicated to the meat, which is thus toughened and shrunken by the firm coagulation of its albuminous constituents. If, however, the stew is kept at the proper temperature, about 180° Fahr.—not even a simmering heat—this does not occur, the meat is tender and juicy and easy of digestion. This is easily secured by a vessel called the *Bain Marie.* It is constructed on the same principle as an ordinary glue-pot. One vessel is fitted inside an outer one. The outer one contains water, which thus surrounds the inner. The vessel is put on the fire, and the meat, vegetables, &c., in the inner vessel, the whole being covered by a lid. The water in the outer vessel comes to the boiling point, but any liquid in the inner one never reaches such a degree because of the loss of heat by evaporation. The water in the outer vessel would require to be raised above the boiling point, which cannot happen, before that in the inner could reach that point. This is the method employed by the continental peasantry, whose stews are famous for their tenderness and delicacy. "The poor peasant, with her 2 or 3 ounces of meat for a large family, puts it into a *pot au feu,* along with what vegetables she happens to have, puts it in after breakfast and leaves it there; it never gets up to boiling point; the meat and vegetables are intermingled, and a nice dinner is obtained for about one-third of what it costs our people of the same class for a lump of salt bacon." Again, the poor French peasant, says Mattieu Williams, does more with one pound of meat, in the way of stewing, than the English cook with three or four. "The little bit of meat and the large supply of vegetables are placed in a pot, and this in another vessel containing water—the *Bain Marie.* This stands on the embers of a poor little wood fire, and is left there till dinner-time, under conditions that render boiling impossible, and demand little or no further attention from the cook. Consequently the meat, when removed, has parted with its juices to the *potage,* but is not curled up by the contraction of the hardened albumen, nor reduced to stringy fibres. It is tender, eatable and enjoyable." Count Rumford says: "In many countries where soups constitute the principal part of the food of the inhabitants, the process of cooking lasts from one meal-time to another, and is performed almost without either trouble or expense. As soon as the soup is served up, the ingredients for the next meal are put into the pot (which is never suffered to cool and does not require scouring); and this pot — which is of cast-iron or earthenware — being well closed with its thick wooden cover, is placed by the side of the fire, where its contents are kept simmering for many hours."

Vegetable food, unlike animal food, can scarcely be too thoroughly cooked, and boiling is for all the most suitable process. Starchy vegetables such as potatoes are not digestible unless they have been boiled sufficiently to cause all the starch-grains to swell and burst their cellulose envelopes. It is this that causes the potato to become mealy by cooling. Sodden and hard or waxy, they are not digestible. Potatoes should be placed in boiling water, with the addition of salt. There is no doubt that boiled potatoes in their skins retain a flavour, of which they are otherwise robbed. The skins of the potatoes do contain some small percentage of a poisonous alkaloid, solanine, which is extracted by boiling and probably destroyed. There is, therefore, some reason for the refusal to use the water in which potatoes have been boiled in their skins; but there is no reason for the throwing away of the water in which peeled potatoes have been boiled, since the alkaloid has been removed in the peelings. Steaming is, however, the most excellent method for the cooking of potatoes, no element of flavour being thereby lost.

Green vegetables require prolonged boiling to make them tender. They should be placed in boiling water, and kept boiling uninterruptedly till removed for being served. As green vegetables are specially valuable for the salts they contain, and as these salts are to a considerable extent removed by water, and specially by soft water, it is better to boil them in hard water or in water to which salt has been added, in the proportion of 2 ounces to the gallon of water.

As regards vegetables like peas, beans, and lentils, their value as food-stuffs depends to a very great extent on their being thoroughly cooked. It has been shown, for example, that when the meal of such food has been used, baked into cakes, and so cooked and eaten, 91·8 per cent of the albuminous constituent was made use of in the body; but when used in their natural form, and boiled after previous soaking in water, only 59·8 per cent was retained in the body; the rest was expelled undigested as waste. This is doubtless partly because of the meal permitting of more thorough cooking, and partly also, no doubt, because of being more readily attacked by the digestive fluids.

Loss in Cooking.—By the various methods of cooking that have been noted the meat, as might be expected, loses in weight. Obviously the loss will be greater in meat roasted or baked, because of the considerable evaporation of water and melting away of fat. The loss is least by boiling, though by this method of cooking it reaches 20 per cent, that is $\frac{1}{5}$ of the weight, so that boiling is the most economical method of cooking. Letheby gives the following table as expressing the loss of different pieces of meat by the various processes:—

	Boiling, per cent.	Baking, per cent.	Roasting, per cent.
Beef generally,..................	20	29	31
Mutton generally,..............	20	31	35
Legs of Mutton, ...	20	32	33
Shoulders of Mutton, ...	24	32	34
Loins of Mutton, ...	30	33	36
Necks of Mutton, ...	25	32	34
Average of all, ...	23	31	34

The following is an example from another source:—

	In Boiling.			In Baking.			In Roasting.	
	lb.	oz.		lb.	oz.		lb.	oz.
4 lbs. of Beef lose... ..	1	0	......	1	3	......	1	5
4 lbs. of Mutton lose..	0	14	......	1	4	......	1	6

THE CONSTRUCTION OF DIETARIES.

The previous consideration that has been given to the uses of food in the body, and to the chemical composition of foods, puts us now in the position of being able to calculate with very considerable accuracy the total quantity of food required per day by persons under various conditions of life, and the proportion of the total quantity which should be contributed by the various kinds of food, albuminous, starchy, and fatty.

The principles on which that calculation is based are considered at length on p. 542, and it may be well to restate them briefly here.

1. A certain quantity of food, which must be proteid, is daily required for the repair of tear and wear of tissues, which tear and wear is practically constant, and not notably varying with work done.

2. A further quantity of food, which may be drawn principally from the starchy and fatty classes, is required, varying, however, with the work done and with the external temperature.

Now it is evident that if the tear and wear of tissue, replaceable by proteid or albuminous foods, is more or less constant, it is only necessary to keep a man under observation for some time to learn how much that daily tear and wear amounts to, and how much nitrogenous food it is necessary to supply daily for its repair. Further, we have seen (p. 533) that even if a man remains perfectly idle, making no exertion whatever, energy is expended in the performance of the vital operations of the body, the beating of the heart, the movements of respiration, &c., and in the maintenance of the bodily temperature. This energy, we have seen (p. 532), is yielded best by the combustion within the body of starches, sugars, and fats, and may be measured by the ultimate products of their combustion which leave the body, specially carbonic acid gas. So that if a set of observations be made upon a man, remaining perfectly idle, one may ascertain not only the amount of nitrogenous food required per day to repair tissue waste, but the minimum quantity also of starches and fats that will suffice to yield energy for vital operations and bodily heat without loss to the body. That is to say, by actual experiment one may learn what is the **Minimum Diet**, consistent with the maintenance of health. If, thereafter, a second set of observations be made upon the same man, who is now set to do a moderate amount of daily work, one may ascertain what is the increased amount of fats and starches, &c., used up in the body to yield the necessary energy, and how much of such foods must be added to the diet to supply it. This set of observations will give the information needed for the determination of what is called **Standard Diet**; that is, the quantity of food daily required by the average man, doing a fair quantity of work, with the maintenance of health. Another set of observations may be made on a man, doing hard work daily, and a dietary may be thereafter constructed to suit his still increased expenditure of energy, and this may be called the **Diet for Hard Work.** Within comparatively recent years a large number of such observations have been made, specially in the Munich Physiological Institute, to which a reference has already been made (p. 540), and a high degree of scientific accuracy has thus been obtained. Previous to such observations the facts which afforded a basis for the construction of dietaries were obtained from observing the quantities of food usually taken by persons under varying circumstances. Thus Dr. Edward Smith calculated the average quantities taken by adult men and women. Dr. Playfair took the average daily food of needlewomen in London, and the average diet of the operatives during the cotton famine in Lancashire in 1862, and considered this to be the barest possible diet. It has been called **Bare-subsistence Diet, Starvation Diet or Famine Diet.** Then he took the mean of the dietaries of English, French, Prussian, and Russian soldiers, &c., as representing the diet of active labourers, and so on. In these calculations the large number of cases from which the average was taken got rid of any errors due to individual excess or deficiency in eating.

Bare-subsistence Diet.—Now we have seen (p. 539) that proteid food may be expressed by the amount of nitrogen it contains, and that the amount of proteid consumed in the body may be ascertained by the amount of urea given off in the urine or by the amount of nitrogen that urea contains. Further, fats and starches may be estimated by the amount of carbon given off from the body; only we must not forget that proteid foods yield carbon also. In short, we may express the quantity of food eaten, or of material used up in the body, simply in grains of nitrogen and carbon, as well as in grains of proteids, fats, and starches.

These things must be remembered in endeavouring to understand the following tables. In an experiment in the Munich laboratory, the subject of it, a watchmaker, did no muscular work, received no food, and lost from his body the following:—

Grains of Nitrogen.	Grains of Carbon.
175·2	3202·8

which represented the amount of flesh and fat of his own body consumed as tear and wear of its machinery, and to yield energy and heat for vital processes.

Now Dr. Playfair's bare-subsistence diet of needlewomen and operatives during famine is as follows:—

Nitrogenous or proteid matter,	2·33	ounces	All calculated as free of water.
Fat,	0·84	,,	
Carbo-hydrates (Sugars and Starches),	11·69	,,	
Total,	14·86	,,	

If we express this in grains of nitrogen and carbon it amounts to—

Grains of Nitrogen.	Grains of Carbon.
160·8	3103·4

So that the quantity of material, lost from the body of a starving man in 24 hours, is very nearly the same as the total quantity of food introduced per day into the body in circumstances of hardship just indicated. Exactly

34 ounces of ordinary white bread, that is, 2 lbs. 2 ounces, yield—

Grains of Nitrogen.	Grains of Carbon.
160	4085

almost exactly the nitrogen of the bare subsistence diet, though 900 grains more carbon. So that we may say this quantity of bread per day is the smallest quantity that it is possible for an adult to maintain existence upon. This amount, however, it is plain, is not satisfactory as a calculating basis for ordinary circumstances, for the body loss of a starving man is not a fair gauge of what the body requires even in circumstances of no work to do, nor is the bare-existence diet of a famine-stricken population. Professor Ranke made an experiment upon himself at Munich with the intention of finding what diet was just sufficient for his bodily wants, when he did no work—with what diet, that is to say, his body would hold its own, neither gaining nor losing. The amount is as follows:—

Nitrogenous or proteid, ...	3·5	ounces	All water-free.
Fats, ...	3·5	,,	
Carbo-hydrates (Sugars and Starches), ...	8·5	,,	
Total,	14·5	,,	

This total, it is to be observed, is less than that of the bare-subsistence diet; but then it is less because of the diminished quantity of carbohydrate, while it is richer in proteids, and much richer in fats, fat being worth twice its weight of carbo-hydrate in richness of carbon. Expressed in nitrogen and carbon this diet equals

Grains of Nitrogen.	Grains of Carbon.
241	3675

Dr. Edward Smith calculated the diets for the average men and women doing no work, and made it as follows:—

	Grains of Nitrogen.	Grains of Carbon.
Adult Man, ...	200	4300
Adult Woman, ...	180	3900

Dr. Letheby gives the following for the adult man (1) during idleness, (2) during ordinary work, (3) during hard work:—

Diet should contain	Grains of Nitrogen.	Grains of Carbon.
For idleness, ...	180	3816
For ordinary work, ...	307	5688
For hard work, ...	391	6823

A very large number of statistics have been collected with the object of determining what is a fair diet for the ordinary working-man, and the above are some samples of the means taken to arrive at a decision.

Standard or Model Diet.—The diet generally accepted as a fair representation not only of the total elements which a diet should contain, but also of the proportion of the various food-stuffs of which they should consist, is that of Professor Moleschott, and is given in the following table:—

Alimentary substances in a dry state required daily for the support of an ordinary working-man of average height and weight.

Nitrogenous or proteid, ...	4·587	ounces avoirdupois.
Fatty matter, ...	2·964	,, ,,
Carbo-hydrates, ...	14·250	,, ,,
Salts, ...	1·058	,, ,,
Total, ...	22·859	,, ,,

This table, it is to be observed, gives the quantities calculated free of water. Food as we take it, however, contains varying percentages of water, as the preceding tables of analysis show. If one takes 50 as the average percentage of water, then the 22·859 ounces dry solids will be 45·718 ounces of food as ordinarily consumed. Besides that there is usually taken in one form or another, as tea, &c., at least 50 to 60 ounces of water.

This standard diet, calculated in terms of nitrogen and carbon, yields:—

Grains of Nitrogen.	Grains of Carbon.
316	4860

Putting it in round numbers, we may say that an ordinary person doing a fair day's work requires a quantity of mixed food that will yield 300 grains of nitrogen and 4800 grains of carbon.

The Calculation of the Value of a Diet.—The problem in constructing a dietary is to furnish these ingredients in the simplest, most palatable, most digestible, and probably also most economical form. It will be of interest now to show how the calculations are made, and how, given any diet whatever, one could estimate its equivalents in nitrogen and carbon. The tables of analysis, which have been given in a very complete form, enable one to determine the dry albuminous, fatty, and carbohydrate material in any given food-stuff.

Let us take four examples as illustration: lean beef, white bread, oatmeal, and potato. The problem is to determine the number of grains of nitrogen and carbon in, let us say, four ounces of each of these substances.

1. Determine what amount of dry nitrogenous (proteid) material, of dry fatty material, and of dry carbo-hydrate (starch and sugar) each contains.

Lean Beef.—100 ounces of lean beef contain, according to table, p. 543:—

Nitrogenous,	19·3 oz.
Fat,	3·6 ,,
Carbo-hydrate,	none.

If 100 ounces of lean beef yield 19·3 ounces dry nitrogenous matter, how much will 4 ounces yield?—

100 : 4 : : 19·3 : *x*.

Multiply 19·3 by 4 and divide by 100.

The answer is ·776 of an ounce.

In the same way, multiplying the quantity of fat in 100 ounces, namely, 3·6, by 4, and dividing by 100, gives the amount of fat in 4 ounces.

Thus

4 ounces Lean Beef contain—

Nitrogenous,	·776 oz.
Fat,	·144 ,,

White Bread.—100 ounces of white bread, according to table (p. 562), contain of—

Nitrogenous,	6·82 oz.
Fat,	·77 ,,
Carbo-hydrate,	52·34 ,,

Proceeding as before,

The quantity of nitrogenous material in 4 oz. is obtained by multiplying 6·82 by 4 and dividing by 100,

of fat by multiplying ·77 by 4 and dividing by 100,

and of carbo-hydrate by multiplying 52·37 by 4 and dividing by 100.

Thus

4 ounces of White Bread contain—

Nitrogenous,	·2728 oz.
Fat,	·0308 ,,
Carbo-hydrate,	2·0936 ,,

Oatmeal.—100 ounces of oatmeal, according to table (p. 563), contain—

Nitrogenous,	16·1 oz.
Fat,	10·1 ,,
Carbo-hydrate,	63·0 ,,

Proceeding as before, we find that

4 ounces of Oatmeal will contain—

Nitrogenous,	·644 oz.
Fat,	·404 ,,
Carbo-hydrate,	2·520 ,,

Potatoes.—100 ounces of potatoes, according to table (p. 569), contain—

Nitrogenous,	2·3 oz.
Fat,	0·3 ,,
Carbo-hydrate,	19·7 ,,

Proceeding again as before, we find that

4 ounces of Potatoes contain—

Nitrogenous,	·092 oz.
Fat,	·012 ,,
Carbo-hydrate,	·788 ,,

These results we may tabulate for ease of future reference thus:—

Amount of Dry Alimentary Substance contained in 4 oz. of Lean Beef, White Bread, Oatmeal, and Potato.

	Lean Beef.	White Bread.	Oatmeal.	Potato.
	ounce.	ounces.	ounces.	ounce.
Nitrogenous,	·776	·2728	·644	·092
Fat,	·144	·0308	·404	·012
Carbo-hydrate,	—	2·0936	2·520	·788
Totals,	·920	2·3972	3·568	·892

2. **The next part of the problem is to determine what quantities of nitrogen and carbon these quantities of nitrogenous, fat, and carbo-hydrate material contain.**

This we are able to do by a table of Dr. Parkes' in which is stated in grains the quantity of nitrogen and carbon in each ounce of these different classes of foods as follows:—

	Grains of Nitrogen.	Grains of Carbon.
1 ounce of Dry Nitrogenous or Proteid material contains,	69	233
1 ounce of Dry Fatty material contains,	0	345·6
1 ounce of Dry Carbo-hydrate[1] material contains,	0	194·2

To find the grains of nitrogen and carbon, therefore, in 4 ounces lean beef, (*a*) we multiply the number of grains of nitrogen (69) in 1 ounce dry nitrogenous material by ·776, the amount of dry nitrogenous material in 4 ounces of beef, and (*b*) obtain the carbon in the same quantity of nitrogenous material by multiplying by 233, adding to that the carbon contained in the ·144 oz. dry fat, thus:—

	Grains of Nitrogen.	Grains of Carbon.
4 ounces Lean Beef contain in ·776 of an ounce Dry Nitrogenous material:		
·776 multiplied by 69	53·544	
·776 multiplied by 233		180·808
4 ounces Lean Beef contain in ·144 of an ounce Dry Fat:		
·144 multiplied by 345·6,		49·7664
Totals,	53·544	230·5744

Working out the figures for the other substances in the same way, we get results expressed in round numbers in the following table:—

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[1] This does not include lactose, the form of carbo-hydrate in milk, which contains only 175 grains of carbon to each ounce.

Grains of Nitrogen and Carbon contained in 4 ounces each of Lean Beef, White Bread, Oatmeal, and Potato.

	Grains of Nitrogen.		Grains of Carbon.
Lean Beef,........................	53½	......	230½
White Bread,....................	19	......	481
Oatmeal, ...	45	......	779
Potato,.............................	6½	......	178½

These four illustrations have been given to show the method of calculation; and it is evident that, from the numerous tables of analysis given in preceding pages, it would be possible for any one, who knows the multiplication table, to work out the grains of nitrogen and carbon in any ordinary diet.

Thus, let us suppose a person took for breakfast the following:—

4 ounces of Oatmeal made into porridge.
10 ,, Sweet Milk.
1 pint of Cocoa (2 breakfast-cupfuls).
¼ lb. White Bread (two thick slices).
½ oz. Butter (enough for the bread).

We can determine how much of the needed daily supply of nutriment he has been provided with. The method of calculation has already been described.

	Nitrogenous.	Fat.	Carbo-hydrate.
	oz.	oz.	oz.
4 ounces Oatmeal yield,	·644	·404	2·52
10 ,, Milk, ,,	·464	·35	·428 (lactose).
1 pint Cocoa, ,,	·03	·092	·025
¼ lb. (4 oz.) Bread, ,,	·2728	·03	2·093
½ oz. (·5) Butter, ,,	·0115	·4215	—
Totals,[1]....	1·4223	1·2975	4·638 and ·428 lactose.

The calculation shows that the diet yields

Grains of Nitrogen.	Grains of Carbon.
100	1757

Suppose the same man lunches on

½ lb. (8 oz.) Mutton Chop,
1½ lb. Potatoes,

and let us suppose there are only 6 ounces edible material in the mutton, the rest being bone. This will yield, calculating in the same way,

Grains of Nitrogen.	Grains of Carbon.
104	1550

which, added to the breakfast, make 204 of the necessary 300 of nitrogen and 3307 of the necessary 4800 grains of carbon. It will be an excellent exercise for any one who has followed these explanations to construct other one or two meals, just sufficient to yield the 96 grains nitrogen and 1493 grains of carbon still wanting to complete a standard diet for a man doing a good day's work.

Proportion of Nitrogen to Carbon in Standard Diet.—To return to the standard diet, we have found that, for the repair of tissue and for the liberation of energy for work and maintenance of heat, it ought to contain 300 grains nitrogen and 4800 grains of carbon. These figures are exactly equal to a proportion of 1 of nitrogen for every 16 of carbon. Now there is no food-stuff which contains exactly this proportion of these two elements, and the most of food-stuffs are very far from it, the animal foods containing the nitrogen in excess, and the vegetable foods, as a rule, containing the carbon in excess. Thus the proportion is as follows:—

In Lean Beef	1 of Nitrogen	to	4⅓	Carbon.
,, Cow's Milk	1	,,	,,	9½	,,
,, **Human Milk**	**1**	,,	,,	**13⅓**	,,
,, **Oatmeal**	**1**	,,	,,	**17⅓**	,,
,, White Bread	1	,,	,,	25⅓	,,
,, Potato	1	,,	,,	27½	,,

Cow's milk contains evidently too much nitrogen to afford an entirely suitable diet for the adult. Human milk is nearly the proportion, but then we must remember that human milk is the diet for development and growth of tissue, and therefore contains a larger proportion of nitrogen than is needed by the full-grown person. Oatmeal comes nearest, containing rather an excess of carbon. It is evident, then, that the due proportion can only be obtained by an appropriate mixing of food, and that it is not possible to obtain it from one food-stuff alone. Thus Moleschott calculated that to obtain the necessary quantity of nitrogenous food for his standard diet *from one source only*, a person would require to eat of—

Cheese fully	12·4 oz.	Wheat Bread	46·3 oz.
Lentils	15·75 ,,	Rice	82·1 ,,
Peas	18·66 ,,	Rye Bread	92·2 ,,
Beef fully	19·7 ,,	Potatoes	320·8 (20 lbs.)
Eggs ,,	31·0 ,,		

And to obtain the non-nitrogenous material (fat, starches, and sugars), the person would require to consume of—

Rice	18·3 oz.	Rye Bread	30·0 oz.
Wheat Bread	20·0 ,,	Cheese	64·5 ,,
Peas	26·0 ,,	Potatoes	65·5 ,,
Lentils	26·2 ,,	Beef	72·5 (4½ lbs.)
Eggs	29·0 ,,		

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[1] Now multiply 1·4213 by 69, and one gets the grains of Nitrogen in the diet.

Then multiply 1·4213 by 233, 1·2975 by 345·6, 4·638 by 194·2, and ·428 by 175; add the results together, and one obtains the grains of Carbon in the breakfast.

The result is, in round numbers,

Grains of Nitrogen.	Grains of Carbon.
100	1757

Thus while 1½ pounds of beef yield the necessary 300 grains of nitrogen, it requires 4½ to give the necessary amount of carbon; so that, to get the necessary amount of carbon from beef, three times the needful quantity of nitrogen is introduced into the body, involving labour in the expulsion of the excess, and probably also working mischief. In the same way if only sufficient rice be eaten to yield sufficient carbon, there is a great deficiency in the supplied nitrogen, and tissue waste is not repaired; while if enough is eaten to yield nitrogen, a great deal excessive carbon is introduced, leading to its being stored up as fat or in some other form.

Instead of expressing the proportion as 1 of nitrogen to 16 of carbon we may express it more simply, though not so accurately, in terms of nitrogenous and non-nitrogenous food-stuffs. When so expressed, we say that a suitable diet for an adult man should contain 1 part nitrogenous food for every 3½ to 4½ parts non-nitrogenous; and this affords one an easier and more rapid way of forming a conclusion as to the suitability of any particular diet. The proportion of nitrogenous to non-nitrogenous constituents of some of the more common foods is as follows:—

	Nitrogenous.	Non-nitrogenous, reckoned as Starch.
Veal,	10	1
Hare's Flesh,	10	2
Beef,	10	17
Lentils,	10	21
Beans,	10	22
Peas,	10	23
Fat Mutton,	10	27
Fat Pork,	10	30
Cow's Milk,	10	30
Human Milk,	**10**	**37**
Wheaten Flour,	**10**	**46**
Oatmeal,	**10**	**50**
Rye Meal,	10	57
Barley Meal,	10	57
White Potatoes,	10	86
Blue Potatoes,	10	115
Rice,	10	123
Buckwheat Meal,	10	130

The only foods that come near to the proportion are human milk, wheaten flour, and oatmeal, the first being deficient in carbonaceous substance and the last in nitrogenous; but the human milk is on this account all the more suited for the growing child, while for an outdoor life, marked by labour and exertion, oatmeal shows itself a well-adapted diet.

Times of Eating.—How is the amount of nourishment shown to be necessary to be introduced into the body? in how many meals? at what times of the day? are questions rather to be answered by each individual, as he finds suitable to his comfort and his business, than to be determined by a code. Certain general rules, however, can be stated with considerable definiteness.

I. The only course consistent with man's business is to introduce the food in several meals, separated from one another by intervals appropriate to the amount taken at each meal, and its nature. There are not very many persons who can devote themselves to any occupation, requiring concentration of thought or energy, soon after a very hearty meal, and it is not desirable that they should. For if a very full meal has been taken, the digestive organs find themselves taxed to their utmost, the circulation becomes exceedingly active through the abdominal organs, meaning a diminished circulation through the nervous system and other parts of the body. This is the explanation of drowsiness after a full meal. Accordingly the diet for the day is distributed in several meals, none of which ought unduly to tax the digestion.

II. The meal-times once arranged should be regularly observed. A habit is very soon established not only with the person himself, but with his digestive organs, which, as the appropriate hour returns, will be prepared, as it were, with the due supply of digestive fluid to meet the expected meal. There is nothing which so disorganizes the paraphernalia of digestion as irregularity, and nothing which is more certain, sooner or later, to establish inveterate dyspepsia.

III. The interval between each recurring meal should be sufficient to permit of a suitable period of rest for recuperation of the digestive energies. What that interval should be may be estimated from reference to p. 601, where the times of digestion of different foods are stated. One may take it that 3½ to 4 hours, on an average, are required for the digestion of an ordinary meal, and, if so, something like an interval of at least five hours should elapse between each meal. Thus if breakfast is taken at 8 A.M., the next meal would not be before 1 P.M.; or if breakfast were at 9 A.M., the next would be at 2 P.M., and the third at 7 P.M., and so on. One must beware of the argument that a shorter interval and more frequent meals may be allowed, if a smaller quantity be taken at each meal. Dr. Beaumont's experiments and observations support the view that, *in a healthy state of body*, a moderately-sized meal is as easily and quickly digested as a small meal. So small a piece of boiled mutton as a quarter of an ounce will require three hours to digest in the stomach, while half a pound, if properly broken down into small portions by the teeth, will be digested in the same time. It is a chemical operation that is being performed, which, within limits, is not affected in time by the quantity to be operated on. It does appear that a moderate meal and a fair interval between each is more suited to man's internal organization in health than small quantities frequently repeated. The latter is, however, in some cases of ill-health, sickness, &c., the most powerful means of treatment.

The common distribution of meals into three principal meals is the one which seems most suitable, whether these meals be breakfast (8–9 A.M.), dinner (1–2 P.M.), tea (6–7 P.M.), or breakfast, lunch, and late dinner. Many, business men in particular, allow themselves really only two good meals a day, breakfast (8–9 A.M.) and dinner (about 7 P.M.). They snatch a bite early in the afternoon, very often a cup of tea or coffee and a biscuit, or such like, sufficient to stave off feelings of emptiness, but not sufficient to yield any amount of nutriment worth calculating. They find it suits their business; and that if they take anything like a fair meal at that time they are not so active, so quick-witted, or so inclined to business as they wish. That may be so, and yet the fact remains that they supply no fresh fuel for the body just at the time when its energies are being expended with greatest rapidity. It is possible to effect a compromise, and while not taking enough to produce feelings of disinclination for work, yet to take sufficient to yield a fair supply of nutriment to the body—such as a basin of soup with bread, a chop or cutlet and potato, a dish of mince-meat and rice, or mince-meat and potato, and so on.

Breakfast at 9 A.M., dinner between 1 and 2 P.M., and tea about 6, is a very common arrangement with the working-classes of this country. If the tea is a fairly-substantial meal, it is a satisfactory enough arrangement. But it very often happens that the tea, consisting of plain bread and butter and tea, is not a very nutritious diet, and then what really happens is that there is no very substantial meal between the dinner of one day and the breakfast of the next. Under such circumstances a light meal one or one and a half hours before bed-time, say of oatmeal porridge and milk, or pease porridge and milk, or bread and milk, would be a most valuable and useful addition. The writer has known business men breakfasting early, dining at 1, taking tea at 5 in the afternoon, and nothing thereafter beyond a biscuit, with some whisky and water. It was not surprising that, under such circumstances, sleeplessness was a common complaint. With such a distribution of meals, a light supper such as has been indicated ought to be taken. Those who dine late require, of course, no further food before bedtime.

The afternoon tea, so popular with the middle and upper classes, taken between early lunch and late dinner is, under ordinary circumstances, not to be objected to, if the tea be freshly made and not too strong. The individual with inclinations towards indigestion had, however, better take care, lest it suddenly arrests the digestion of his lunch, not yet completed, and brings him to dinner with a stomach most unwilling to receive as yet any further supplies.

It may be remarked in concluding these considerations that the resistance of the body to disease, particularly to infection, is least after a long fast. It is, therefore, undesirable to engage in the day's work unfortified by food, specially if one's business brings one within the reach of any unhealthy influence. "It is well known," says Dr. Combe, "that the system is more susceptible of infection, and of the influence of cold, miasma, and other morbid causes, in the morning before eating than at any other time; and hence it has become a point of duty with all naval and military commanders, especially in bad climates, always to give their men breakfast before exposing them to morning dews and other noxious influences. Sir George Ballingall even mentions a regiment quartered at Newcastle, in which typhus fever was very prevalent, and in which, of all the means used to check its progress, nothing proved so successful as an early breakfast of warm coffee. In aguish countries, also, experience has shown that the proportion of sick among those who are exposed to the open air before getting anything to eat, is infinitely greater than among those who have been fortified by a comfortable breakfast." "In some constitutions," says Pereira, "especially those denominated delicate, much exercise, either of body or mind, before breakfast, operates injuriously, producing exhaustion, languor, and unfitness for the ordinary occupations of the day. These facts show the importance of breakfasting soon after rising and dressing, at least in many cases. I am fully aware that there are numerous exceptions to this. Some persons not only suffer no injury from, but actually appear to be benefited by, active exercise taken before breakfast, its effect being with them to create or augment the appetite. But in others the effects are those which I have already stated. I am satisfied, from repeated observation, that in children disposed to spasmodic and other brain diseases, the practice of making them attend school for two hours before breakfast is injurious; and I fully agree, therefore, with Dr. Combe, that in boarding-schools for the young and growing, who require plenty of sustenance, and are often obliged to rise early, an early breakfast is an almost indispensable condition of health. Epileptics, and especially those disposed to morning attacks, should invariably breakfast soon after rising. I think I have seen the fits brought on by neglecting this precaution. For travellers a light breakfast before starting is a great protection against colds and subsequent fatigue or exhaustion."

These general rules are all that one can lay down with any pretension to wide application. Within them individuals must consult their own tastes, business habits, and it may be also personal peculiarities. Nevertheless, any one who passes much outside of such general regulations will probably find, in time, that he has erred and incurred the punishment of digestive evils, which once induced are not very easily exorcised.

Variations in Diet according to Age, Sex, Work, or Exercise.—To consider the effect of work and exercise first. We have already had abundant occasion for observing that the broad principle on which diet should be varied with work is, that energy for work is liberated most easily and economically from fats and sugars and starches. So when there is increased work or exercise, calling for more food, the increase should take the form mainly of additions of these to the diet, and not so much of meaty constituents. As a matter of practical experience it is found that some increase in the nitrogenous foods is also demanded, not because of increased tissue waste, but because an increased supply of digestive fluids in the alimentary canal is needed for the digestion of the added supply of food, and these cannot be manufactured in the body without an increase in the quantity of nitrogenous food. Further, it is found that the consumption of foods of the animal kind stimulate the combustion within the body of fatty and starchy materials, and thus the energy is more rapidly liberated from the latter kinds of food when an increased supply of animal, or, to speak more correctly, nitrogenous food is taken with them. Nevertheless it is true that the added labour is to be accomplished at the expense principally of fatty and starchy food.

As regards age: the standard diet applies to the prime of life. Modifications are requisite for the extremes of youth and old age. The relative quantities required for different ages are shown in the following table, which represent the smallest amount of food, according to the investigations of the Munich physiologists, necessary for different ages:—

	Nitrogenous.	Fat.	Carbo-hydrate.
Child under $1\frac{1}{2}$ years, ...	$\frac{3}{4}$ to $1\frac{1}{4}$	1 to $1\frac{1}{2}$ fully	$2\frac{1}{10}$ to $3\frac{1}{10}$.
Child from 6 to 15 years, ...	$2\frac{4}{10}$ to $2\frac{8}{10}$	$1\frac{1}{3}$ to $1\frac{3}{4}$	$8\frac{8}{10}$ to $14\frac{1}{10}$.
Man (moderate work), ...	$4\frac{1}{10}$	2	$17\frac{6}{10}$.
Woman, ...	$3\frac{1}{4}$	$1\frac{1}{2}$	$14\frac{1}{10}$.
Old Man, ...	$3\frac{1}{2}$	$2\frac{4}{10}$	$12\frac{3}{10}$.
Old Woman, ...	$2\frac{8}{10}$	$1\frac{3}{4}$	$9\frac{1}{10}$.

The figures denote ounces and fractions of ounces, and the quantity does not include water, but represents the dry nitrogenous, &c., material. By doubling the figures one will obtain the quantities, as applicable to food in the ordinary state in which one consumes them.

As regards the food of children, the really essential thing to remember is that they require a larger proportion of nitrogenous food than the adult, to meet the demand for material with which to build up bone, muscle, &c. Human milk supplies that demand, containing, as we have several times noted, a larger proportion of nitrogen as compared with carbon than is suitable for the adult. On the other hand, these facts are so little known that the prevailing practice is, as soon as a child ceases to be fed with milk, to supply it with food of all others deficient in the very element in which it should abound—corn-flour, tapioca, arrow-root, semolina. These, as we have observed (p. 542), are practically entirely devoid of nitrogen, are almost exclusively starchy in character, and starch is just the class of food-stuff which the child's digestive apparatus is least fitted to deal with. There is no starch in milk, though there is sugar. Such foods are only made tolerable for a child by the milk with which, in part, they are usually made and administered. Well, then, a child's diet ought to be rich in nitrogenous food-stuffs. Here again is oatmeal eminently serviceable, made into well-cooked porridge, with additions of soup, broth, egg, &c., as mentioned in detail on p. 450. With children more frequent meals with shorter intervals are required, prolonged fasting being badly borne. In determining whether a child is receiving a sufficient diet, one must not lay too much stress upon gain in weight alone. Weight may be gained through deposition of fat, owing to a diet excessively rich in starch, sugar, or fat, while all the time the child is suffering from nitrogen starvation. It is not uncommon to see a big, fat child, which would be called a picture of health but for its pasty complexion, but with bones so soft that they yield to its own weight. Such is the result of a diet too rich in starch, and wanting in nitrogenous food. Therefore, in estimating the health and healthy growth of a child, one must take into account not only weight, but firmness of flesh, redness of lip and cheek, and straightness of bone. Soft flesh, yielding bones, and white face proclaim with absolute certainty improper *quality* of food, no matter what may be the *quantity* the child is consuming. The food of children ought to be given in a more dilute condition than that of adults. They are more likely "to have too little water in their food than too much." "Hardly ever is there a mother or a nurse who imagines that a child can be thirsty without being hungry at the same time. Much discomfort and a good deal of sickness is a result of the fact that infants must eat in order *not* to be thirsty, and have frequently to go thirsty because an over-exerted and disordered stomach will not accept any more food." There is undoubtedly a necessity of mothers now and then giving some water to their children.

The following examples of children's dietaries may be useful:—

St. Thomas's Hospital, London.

(Intended for all Children under 10 years of Age.)

Mixed Diet:—12 oz. Bread; $\frac{3}{4}$ oz. Butter; $\frac{1}{2}$ pint Milk for Breakfast, the same for Tea; 2 oz. Mutton, when dressed, roast, or boiled alternately; $\frac{1}{4}$ lb. Potatoes or fresh Vegetables; 6 oz. of Rice or Bread Pudding; $\frac{1}{2}$ pint of Milk.

Milk Diet:—Daily—$1\frac{1}{2}$ pints of Milk; 8 oz. Bread; $\frac{1}{2}$ oz. Butter; 6 oz. Rice or Bread Pudding.

Birmingham General Infirmary.

Full Diet:—Breakfast—1 pint of Milk.
Dinner— 2 oz. Cooked Meat, 6 oz. Potatoes, and 6 oz. Bread.
Supper— $\frac{1}{2}$ pint of Broth or Gruel.

Glasgow Sick Children's Hospital.

	1st (Milk Diet).	2d.	3d (Full Diet).
Breakfast, 8 a.m.	Bread and Butter.* Bread and Milk.	Porridge, $\frac{1}{3}$ pint. Bread and Butter.*	Porridge, $\frac{1}{3}$ pint. Bread and Butter.*
Dinner, 12 noon.	Milk Pudding. Extras as ordered.	Broth, $\frac{1}{2}$ pint. Bread. Milk Pudding.	Minced Collops of Beef or Mutton, $2\frac{1}{2}$ oz. cooked, or Stewed Rabbit. Mashed Potatoes, 3 oz. Milk Pudding.
Tea, 4 p.m.	Milk. Bread with Butter.*	Cocoa, $\frac{1}{3}$ pint. Bread with Butter,* Dripping, or Treacle.	Cocoa, $\frac{1}{3}$ pint. Bread with Butter,* Dripping, or Treacle.
	At 5 a.m. and 7 p.m., Milk with "a piece." Total quantity of Milk per day, 1 pint.	Total Milk per day, 1 pint.	Total Milk per day, 1 pint.

* Butter $\frac{3}{4}$ oz. daily, and Bread as much as is desired.

Broth.—Alternately Hough and Neck of Mutton, $\frac{1}{2}$ lb. to pint.

Puddings.—Rice, Sago, Tapioca, Bread and Butter with Eggs, all made with Milk and Sugar—Milk $\frac{1}{2}$ pint per Child.

Extras.—Custard (1 Egg to $\frac{1}{2}$ pint Milk), Chicken Soup, Chicken, Eggs, Chops, Fish, Meat-extract, Raw-meat, Beef-juice, Beef-tea (1 lb. to the pint, or stronger if ordered), Jellies, Isinglass, Cornflour, Arrow-root, Stimulants, Barley-water and Aerated-waters, Cabbage, Turnips.

Dinner.—In order to secure variety, all on Broth and Meat Diet will have a Fish Dinner on Wednesday. On other days the Meat Dinner will go the round of the articles mentioned; and the Sisters will exercise their judgment to suit varying appetites by interchange and sharing of diets, so far as consistent with Medical restrictions.

School Boys about 10 years of age should receive about $\frac{1}{2}$ the nitrogenous food required by active men, and about $\frac{3}{4}$ths the quantity of carbonaceous food.

Diet for the aged, it has been urged, should, in its kind, approach more nearly to that of childhood. As a rule there is less activity in all the bodily processes, slower heart-beat, slower respiration, and diminished combustion changes going on. All this implies less consumption of material, and is usually accompanied by diminished appetite, weaker digestion, and increased sensitiveness to cold. This implies as a whole less food, and the proportion between the diet of the active man and that of the old man is shown in the table on p. 617. The kind of food given should also be such as will suit the enfeebled digestive powers. Milk may, with advantage, bulk largely in it, fish, eggs, butcher-meat also, but in diminished amount, milk puddings and so on. Whatever be the opinion as to the use of stimulants by the healthy among young men and women, and men and women in their prime, there is no doubt that the aged feel the benefit of some small amount of stimulant, adding as it does to their relish for food, and aiding its more rapid digestion. An old person cannot with impunity indulge in a full and rich diet, unless he is leading as active and vigorous a life as the man in his prime. The favourite example of how a healthy old age can be attained on a very simple diet is that of Cornara, "a Venetian of noble descent, who lived in the 15th and 16th centuries, and attained an age of upward of 100 years. Impressed with the conviction that the older a man gets and the less amount of power he possesses the less should be the amount of food consumed, in opposition to the common notion that more should be taken to compensate for his failing power; he, at about 40 years of age, resolved to enter upon a new course, and betake himself to a spare diet and scrupulously regular mode of life, after having, as he says, previously led a life of indulgence in eating and drinking, and having been endowed with a feeble constitution and "fallen into divers kinds of disorders, such as pains in my stomach, and often stitches, and spices of the gout, attended by what was still worse, an almost continual slow fever, a stomach generally out of order, and a perpetual thirst." He also did all that lay in his power, "to avoid those evils which we do not find it so easy to remove. These are melancholy, hatred, and other violent passions, which appear to have the greatest influence over our bodies. The consequence was," he goes on, "that in a few days I began to perceive that such a course agreed with me very well; and by pursuing it, in less than a year I found myself (some persons, perhaps, will not believe it) entirely freed from all my complaints . . . I chose wine suited to my stomach, drinking of it but the quantity I knew I could digest. I did the same by my meat, as well in regard to quantity as to quality, accustoming myself to contrive matters so as never to cloy my stomach with eating and drinking; but constantly rise from the table with a disposition to eat and drink still more. In this I conformed to the proverb which says that a man, to consult his health, must check his appetite. . . . What with bread, meat, the yolk of an egg, and soup, I ate as much as weighed in all 12 ounces, neither more nor less. . . . I drank but 14 ounces of wine." He remained in possession of all his faculties to the close of his life, and wrote his treatises between his eighty-third and ninety-fifth years.

As regards Sex: women require less food than men, when engaged in indoor work—a tenth less, it has been estimated. "Ladies in luxurious repose consume about the same amount as young school-boys." If women are engaged in active outdoor work, as in farm service, their diet approaches more nearly that required for active men.

The Regulation of Diet according to Season or Climate.—The differences in our household arrangements, as regards heating, between winter and summer afford a rough, but very accurate notion of the differences within the body, according to the degree of coldness of the external atmosphere. In cold weather we burn more coals or other fuel to keep up a moderate temperature in the house, and in the body an increased combustion of the heat-yielding substances goes on to maintain the regular temperature of the body. These substances are specially carbo-hydrates and fats, but more particularly the latter. To supply the material for this increased combustion more food is necessary, and particularly more fatty and starchy food. Thus our food should vary in nature and amount with the change of seasons in our temperate climates, just as our consumption of coal varies, or just as the nature of our clothing varies. In persistently cold regions of the earth, in the arctic regions, for example, the inhabitants regularly consume a much larger daily supply of food than anything we are accustomed to; and fatty substances form a very large proportion of the diet. The air in these regions is condensed because of the cold, and a given volume of air will contain a much larger quantity of oxygen than the same volume in a temperate climate, and still more than the same volume in a hot climate. Fats contain a considerably larger proportion of carbon than sugars or starches, and thus the larger quantity of oxygen in the air and the greater proportion of carbon in the fat form the complement of one another, the supporter of combustion and the combustible substance. These facts account for the large quantity of food eaten by the inhabitants of cold regions. It is a matter of common observation in cold climates, or in a very cold season of a temperate climate, that the badly-fed labourer does bad work, and is among the first to succumb to cold. According to Sir John Ross, an Esquimaux will eat perhaps "twenty pounds of flesh and oil daily," and the children of the arctic regions find fatty substances more toothsome morsels than sweetmeats. According to Sir Anthony Carlisle, "in one of those late extravagant voyages to discover a north-west passage, the most northern races of mankind were found to be unacquainted with the taste of sweets, and their infants made very wry faces, and sputtered out sugar with disgust; but the little urchins grinned with ecstasy at the sight of a bit of whale's blubber." But such an explanation hardly covers the enormous gastronomic feats related by travellers, such as Sir George Simpson's two men of the Yakuti, who in less than two hours and a half consumed each 36 avoirdupois pounds of beef and 18 lbs. of butter. The fact that, after such a feast, the men remain in a state of stupor for three or four days, without further food or drink, and are meanwhile rolled about to promote digestion, shows how abnormal is the diet and how unjustified by the extreme and enduring cold. Great eaters have also been found in climates which made no demand for extraordinary diet—among the Hottentots and Bosjesmans, for example. The point to note is, nevertheless, that a cold external temperature demands a larger than usual supply of food, and that fatty food should bulk largely in the added quantity, the internal combustion of the fat doing far more for the maintenance of bodily warmth than extra clothing.

In warm climates the conditions are reversed, the external temperature may be at certain times above the bodily temperature. Consequently there is less need for liberation of heat within the body. A diminished supply of food is, therefore, required, and of a kind whose combustion will not yield heat in great amount. Moreover the atmosphere is rarefied, and a supply of oxygen for the combustion of highly-carbonaceous food would involve laboured respiration. Rice and sugar contain carbon in much less quantity than fat (see p. 532), 100 parts of starch requiring 120 of oxygen for complete combustion, whereas 100 of fat require 293 of oxygen. Moreover, starches contain a very considerable proportion of oxygen wherewith the combustion may be accomplished, so that starchy foods and other light vegetable diets are evidently best suited for hot climates. The fruits and vegetables preferred by Southerns yield only about 12 per cent of carbon, while the whale's blubber enjoyed by the Greenlander yields 66 to 80 per cent.

The frequency of diseases of the liver in hot seasons and tropical climates, was ascribed by Liebig to the accumulation of carbon in the system. It is, at any rate, due to the accumulation within the body of nutritive material in excess of the bodily demands, and in excess of what the bodily processes can dispose of under the climatic conditions. Thus, speaking of diet in India, Sir Joseph Fayrer says "the diet should be plain and simple. New arrivals should abstain from much animal and stimulating food, with a view to avoid plethora, dyspepsia, malassimilation, and congestion of the already over-taxed liver and eliminative organs. Curries, as generally prepared, should be sparingly consumed." He urges that the mode of living should not be rapidly changed by those arriving from a temperate climate. The habit of the digestive organs is not to be upset with impunity, and therefore the natives should not be copied in respect of diet, but the usual European diet should be gradually modified to suit the altered conditions of climate. Considering the variety of the ordinary British feeding this can be very easily done, the principles being the diminution in the total quantity of nutritive material (which can be done without diminishing the bulk of the diet by substituting articles less rich in nutriment), the substitution of vegetable diet for fatty materials, and increase in fruits. Fayrer says that, as a general rule, people eat too much in India, more than they can assimilate. As an example of a dietary he says, "a cup of chocolate, cocoa, coffee, or tea may be taken before starting for the morning ride or walk; a plain breakfast of the same, with bread and butter and eggs, or a little bit of chicken (more than the bread and butter is not often needed); luncheon or tiffin at 1 or 2 P.M., with very little animal food, a cutlet or the leg of a fowl with vegetables will suffice. . . . The evening is the best time for dinner—the principal meal of the day. It should be plain and simple, with as few dishes as possible. Nothing can be more prejudicial than a great variety and number of highly-seasoned courses. 'To leave off with an appetite' is a good maxim in temperate climates, and better still in tropical. . . . It may be generally stated that temperance both as regards food and drink is of cardinal importance." To every other hot climate besides India these precepts are equally applicable.

In temperate climates a mean between these two extremes is indicated, which is yielded best by a mixed animal and vegetable diet, and which is made to vary in quantity and in the proportion of the fatty and starchy ingredients with the changes of the season.

It would be a very great benefit to the health of the population of Great Britain if these changes in diet required by the seasons were more recognized than they are, more particularly if the indications for the adoption of a more fatty or oily diet, with the advent of the colder months, were followed. During the cold season it is not cold simply with which we have to contend, but a raw cold, a moist cold, due to the quantity of watery vapour in the atmosphere. On the continent of Europe the cold is often much more intense, but it is more easily borne, because of the crispness and dryness of the air. The cold moist atmosphere robs the body of its heat with far greater quickness and more unequally. The garments become moist, and their power of conducting heat away from the body becomes greatly increased, so that it is a matter of great difficulty, when engaged out of doors, to maintain the bodily temperature at its uniform rate. These are just the circumstances which demand more rapid combustion of highly carbonaceous substances, such as fat, in the body. It is because it meets such a demand that the free use of cod-liver oil as a medicament is found so beneficial in our climate during the winter months, and just for the same reasons that it derives its value in warding off lung affections. Let the lean man, or the young lady who, in spite of her furs, shivers at the bare approach of "chill November," take to cod-liver oil, or to a plentiful supply of fat meats in the dietary, with the close of September, and they will both be compelled to confess that they never passed through a winter with such comfort and with less sensitiveness to the cold.

Diet for Training.—When a person goes into training for the purpose of being fitted for some great exertion of strength or of speed, there are several objects which he wishes to attain by the process. He wishes to increase the vigour of his muscles by adding both to their firmness and their actual bulk; he wishes to free his body of deposited fat; he wishes to increase the expansion of his lungs by developing his respiratory muscles, in order to "increase his wind;" he wishes to increase the strength and regularity of the contractions of the heart, so that its action will not become tumultuous under the exertion; and he wishes to unload of accumulated effete products the organs for the removal of waste, so that they shall be free actively to deal with the waste products rapidly produced under exertion. These objects are accomplished mainly by diet and exercise. Exercise, when properly arranged and graded, increases the tone and actually causes increased development of muscle—the muscles of locomotion, of respiration, and of the heart alike. It is the most rapid means of clearing out the excretory organs, and of causing the consumption of stores of fat and glycogen laid down in the body. The diet to be appropriate must fulfil certain indications. In the first instance it must never be in excess, and it must be of the most easily digested kind. Then it must supply material for the rapid increase of muscular development, and must on that account consist largely of nitrogenous material. Moreover, at the beginning of training, the diet, being mainly nitrogenous, stimulates the consumption within the body of the accumulated fats and carbo-hydrates. At the same time the diet, particularly as the training progresses, when the body has lost its fat, must not be so devoid of fat and carbo-hydrate as to cause the tissue of the body itself to be called upon for the supply of energy, as that would rapidly diminish the power of endurance. This is what "overtraining" leads to. Lean meat, therefore, enters largely into the diet, cooked by broiling or roasting, and not overdone. "Beef and mutton are the meats to be preferred, and it is not necessary that all the fat should be excluded. Stale bread or dry toast, potatoes, and some kind of green vegetables in moderation, are the appropriate articles to be taken in conjunction. Water-cresses are considered good. Pastry, flour-pudding, sweets, and made dishes, should find no place in the dietary of the man in training. The farinaceous articles, as rice, sago, &c., are allowable, but should only be taken to a moderate extent. To avoid too great sameness is an important point, especially with those who have been previously accustomed to a liberal diet; at the same time it is not desirable that the person should be tempted to eat to satiety. A full stomach, as is well known, disposes to inactivity. Condiments, as pickles, sauces, &c., are objectionable, on account of their effect being to force an appetite, which should be simply allowed to have its natural play. . . . The sensation of thirst may be taken as affording a correct guide upon the point of the amount of liquid to be consumed; but instead of drinking freely at a draught to satiety, the liquid should be sipped in small quantities, to give time for absorption, and thus satisfy thirst without incurring the risk of introducing a surplus amount into the stomach. In this way the error is not likely to be committed of drinking too much. The liquids consumed must be of a simple and unexciting nature. Beer and the light wines are allowable, but spirits should be scrupulously avoided. Tea, coffee, and cocoa may be taken according to inclination, and, as a simple drink, nothing is better than toast and water, or barley-water. The proper number of meals to be taken during the day consists of three—viz., one about 9 A.M., the second between 1 and 2 P.M., and the third in the early part of the evening;" this is how Dr. Pavy summarizes the requirements of diet for training.

The following shows the system adopted at Cambridge in the training for the summer races:—

Rise at 7 A.M. A run of 100 or 200 yards as fast as possible.

Breakfast, at 8·30 A.M., of meat—beef or mutton—underdone; dry toast; tea—two cups, or, towards the end of training, a cup and a half only; and water-cresses occasionally.

Dinner, about 2 P.M., of meat—beef or mutton; bread; vegetables—potatoes, greens; and one pint of beer. (Some colleges have baked apples, or jellies, or rice-puddings.) For dessert, oranges, or biscuits, or figs, with two glasses of wine.

About 5·30 P.M. a row to the starting-point and back.

Supper, about 8·30 or 9 P.M., of cold meat; bread; vegetables, lettuce or water-cresses; and one pint of beer.

Retire to bed at 10 P.M.

Economy in Diet.

"Cheap and nasty" is generally regarded as a saying which is not very often inaccurate when applied to clothing, to furniture, and such like articles. That it is equally applicable to food is a belief not easily dislodged from the minds of the people. Cheap beef must necessarily be inferior beef, the less expensive portions of a carcass must be the poorer portions of it, are articles of this creed; and if there is one class of the population that looks upon the attempt to live cheaply as mean and degrading, it is the class that can least afford to spend more than is absolutely necessary upon the diet. The estimation of the value of food by its cost is wholly arbitrary, and, as we shall see, misleading. If the true method of estimating the value of food-stuffs by their capacity to nourish the body, and the means by which such an estimation could easily be made, were properly understood by the people, a complete revolution would speedily be effected in the dietaries of the poorer classes. Money that is wasted on dearer food-stuffs, under the delusion that they are the stronger and more nourishing, would be saved, if only to give variety by the extras that could be purchased with it, and perhaps to improve the condition of the thrifty in some other direction. A few examples will best show the relation between nutritive value and cost. The following table exhibits the quantity of nutritive material contained in half a pound (8 ounces) of each substance, and its cost:—

½ lb. of	Oatmeal	yields of nutritive material	7·136	ounces	at a cost of	1*d.*
,,	Fine Flour	,, ,, ,,	6·848	,,	,,	1*d.*
,,	Bacon	,, ,, ,,	6·648	,,	,,	5*d.*
,,	Pease-meal	,, ,, ,,	6·499	,,	,,	1*d.*
,,	Indian Corn Meal	,, ,, ,,	6·424	,,	,,	½*d.*
,,	Sago	,, ,, ,,	6·2	,,	,,	1*d.*
,,	Peas (dried)	,, ,, ,,	5·995	,,	,,	1*d.*
,,	Figs	,, ,, ,,	5·832	,,	,,	2*d.*
,,	White Bread	,, ,, ,,	4·794	,,	,,	¾*d.*
,,	Dunlop Cheese	,, ,, ,,	4·618	,,	,,	5*d.*
,,	Rye Bread	,, ,, ,,	4·349	,,	,,	½*d.*
,,	Fowl	,, ,, ,,	2·060	,,	,,	7*d.*
,,	Egg	,, ,, ,,	2	,,	,,	4½*d.*
,,	Salmon	,, ,, ,,	1·997	,,	,,	7*d.*[1]
,,	Lean Beef	,, ,, ,,	1·832	,,	,,	6*d.*[1]
,,	Potato	,, ,, ,,	1·784	,,	,,	¼*d.*
,,	Cod	,, ,, ,,	1·72	,,	,,	2*d.*[1]
,,	Milk	,, ,, ,,	·994	,,	,,	¼*d.*
,,	Buttermilk	,, ,, ,,	·698	,,	,,	⅜*d.*

Or we may represent the same thing by putting down the quantities of nutritive material 1*d.* will buy in the form of each of these different substances:—

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[1] Allowance is made in calculating the cost for a considerable portion not edible, bones, &c.

	Nutritive material in ounces.	
1*d.* will buy	12·848	as Indian Corn Meal.
1*d.* ,,	8·698	,, Rye Bread.
1*d.* ,,	7·136	,, Oatmeal.
1*d.* ,,	7·136	,, Potato.
1*d.* ,,	6·848	,, Fine Flour.
1*d.* ,,	6·449	,, Pease-meal.
1*d.* ,,	6·392	,, White Bread.
1*d.* ,,	6 2	,, Sago.
1*d.* ,,	5·995	,, Peas (dried).
1*d.* ,,	2·916	,, Figs (dried).
1*d.* ,,	1·864	,, Buttermilk.
1*d.* ,,	1·329	,, Bacon.
1*d.* ,,	1·324	,, Milk.
1*d.* ,,	·923	,, Cheese (Dunlop).
1*d.* ,,	·86	,, Cod Fish.
1*d.* ,,	·445	,, Egg.
1*d.* ,,	·305	,, Lean Beef.
1*d.* ,,	·294	,, Fowl.
1*d.* ,,	·285	,, Salmon.

Taking four of these, and expressing the nutritive material in terms of nitrogen and carbon, we find that—

	Grains of Nitrogen.	Grains of Carbon.	
1*d.* will buy	90	and 1558	as Oatmeal.
1*d.* ,,	52	,, 1428	,, Potato.
1*d.* ,,	50½	,, 1282	,, White Bread.
1*d.* ,,	18	,, 77	,, Lean Beef.

Thus one penny's-worth of oatmeal will give almost 5 times the nitrogen of one penny's-worth of lean beef and 20 times the amount of carbon, and three pennies expended on oatmeal will buy 270 grains of nitrogen and 4674 grains of carbon,—almost the very quantity required for the daily supply of a man doing active work.

In the prison of Glasgow the following diet was given to 10 prisoners (5 men and 5 boys), all under sentences of two months' imprisonment, and all employed at light work, picking hair and cotton:—

Breakfast:—8 oz. oatmeal made into porridge, with a pint of buttermilk.

Dinner:—3 lbs. of boiled potatoes, with salt.

Supper:—5 oz. of oatmeal made into porridge, with half a pint of buttermilk.

At the beginning of the dietary eight of the prisoners were in good health and two were in indifferent health; at the end all were in good health, and they had on an average gained more than 4 lbs. each in weight, only one prisoner (a man) having lost in weight. The greatest gain was 9 lbs. 4 oz., and was made by one of the men. The prisoner who was reduced in weight had lost 5 lbs. 2 oz.

This diet contains 302 grains of nitrogen and 5260 grains of carbon, more than the full quantity required per day for active work. Its cost, including cooking, is 2¾*d.*[1]

As a final illustration of the fact that the dearer diet is not necessarily the most nourishing, we may give an example of two breakfasts.

We take first the breakfast given on p. 614, the nutritive material of which has been there calculated.

BREAKFAST A,

	Yields	Costs
4 ounces Oatmeal, made into porridge, 10 ounces Milk, 1 pint Cocoa, ¼ lb. Bread, ½ oz. Butter,	100 grs. Nitrogen, 1757 ,, Carbon,	3*d.*

BREAKFAST B,

	Yields	Costs
1 pint Coffee, 1 Egg, ¼ lb. Bacon, ½ lb. Bread, 1 oz. Butter,	79½ grs. Nitrogen, 1792 ,, Carbon,	5¾*d.*

The advantage here lies with breakfast A, its 20½ grains of nitrogen in excess of B being of more benefit than B's 35 grains excess of carbon. Yet breakfast A consists of half the quantity of bread and butter. It is plain that the egg and bacon, which add to the cost of B, do not yield the nutriment contained in the oatmeal of A. The cost of A would be still further reduced by substituting buttermilk for sweet milk. The cocoa is also counted to the advantage of A, for it contains a large quantity of nutriment, as shown in the table in next section, and, as prepared, the cocoa is all consumed, whereas coffee is used only in infusion, which contains really no nutritive properties, though it possesses markedly stimulating qualities. These illustrations are sufficient to show that a person may live cheaply and yet introduce into the body all the nutriment necessary in a highly useful and digestible form.

Effects of Excessive or Deficient Diet.

The Effects of Deficient Diet are shown in their most extreme form in cases of starvation. In such a condition the tear and wear of tissue is not replenished, and the amount of nitrogen, expelled in the urine, indicates the exact loss of organized tissue. The amount falls for two or three days after food ceases to be given, as if some surplus proteid matter, not distinctly built up into tissue, were first consumed, and thereafter the amount expelled remains at a certain minimum daily amount, which seems to bear a proportion to the body weight. The material needed to yield energy for vital operations and for the maintenance of heat is derived from the stored-up fat of the body to begin with. Thus after the first few days, when stored-up material is all consumed, the vital functions are carried on at the expense of the tissues themselves, which gradually undergo oxidation to meet the demands. If the temperature of the body be maintained by external means, death by starvation will be delayed, because less consumption of material is necessary to yield heat. It has been found that death occurs in the case of man—cases of complete abstinence from food and drink—in 8 to 10 days, but in some cases it has been observed to be delayed to from 21–24 days; but the period will, of course, depend upon the condition of the body to begin with—upon the quantity of stored-up material it may possess. When water is supplied the period is lengthened. In the case of six melancholiacs, who took water, death did not occur for 41 days. It is remarkable to observe the differing degrees to which the various organs suffer. By the time death occurs almost all fat has disappeared from the body. Next to fat the glandular organs suffer most, the spleen losing 63 per cent of its weight and the liver 56 per cent. The muscles lose 30 per cent, and the blood 17 per cent. The heart and central nervous system lose very little. Their nourishment seems to be maintained at the expense of the other tissues, their activity being so absolutely necessary to continued existence. The immediate cause of death appears to be inability longer to maintain a high enough temperature owing to the combustion of the chief heat-yielding substances. A condition of torpor, similar to that produced by cold, sets in, and leads to death. The person may be roused from this condition by the application of heat; and this is the first thing to be done, in attempted rescue from starvation, viz. to restore bodily warmth, and to supply food very slowly and gradually.

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[1] The calculation of the nutritive equivalents is made from the table on page 563, which gives the analysis of the finest oatmeal. Probably the meal actually used would not show such a good analysis, and we may, therefore, allow that probably the diet would scarcely contain so much nutritive material as the calculation represents. Even with such an allowance it is a substantial and sufficient diet. Then the estimate of cost is low, because in a prison, where enormous quantities are bought, it is a wholesale price that is paid, and considering the number cooked for the expense of cooking would be trifling. The same materials bought by the working man or his wife could scarcely cost less than 3¾*d.*

Now if a well-nourished person suffers for a few days only from deficient diet, the tissues of the body will not feel the loss, any stored-up material being sufficient to yield the deficit. If, however, the deficiency be long continued, this stored-up material will disappear sooner or later according to the daily amount of the deficiency, and, thereafter, any continued deficit will have to be made good from the tissues themselves, so that a modified and slow state of starvation will arise, weight will be steadily lost, and the characteristic results of the deficit will appear. This state of modified starvation may arise, even though the diet may appear to be abundant in quantity, and even though the person may actually gain in weight. Thus a diet may regularly contain more fats and carbo-hydrates than the person requires for energy and heat, excess being stored in the body, but the diet may, at the same time, be deficient in nitrogenous foods, so that the person is daily expelling from the body, as the result of tear and wear, more nitrogen than the diet yields, the excess of expenditure over income being drawn from the muscles, &c., while the loss in nitrogen is not in bulk so great as the gain in fat, and is, therefore, masked. A state of nitrogen starvation may thus arise while the person becomes actually fatter. This is not so uncommon among children fed on too starchy food. The evidence of this would be found in the absence of a healthy colour and in the flabbiness of the muscles and thinness of the bones felt beneath the fatty layer under the skin. As a rule, however, defective diets are so all round, and general leanness, loss of strength, languor, and general weakness betoken the true condition.

The Effects of Excessive Diet are much more common than those of defective diet. There is no doubt that many people habitually eat to excess, being urged thereto by sauces, condiments, stimulants, &c. With a plain, simple fare, a healthy appetite usually speedily indicates when the stage of satisfaction has been reached, and there is little temptation to pass beyond it. But with a great variety of food, made dishes, and culinary devices, healthy instinct is confused or disobeyed. A single excess will, of course, lead only to temporary disturbance, but continued excess leads to marked and wide-spread disturbance. Fat accumulates in the body, the liver becomes oppressed with its stores of unnecessary material, digestion becomes impaired from the excessive demand upon its operations, the attempt to dispose of the excessive material burdens the organs of excretion, and, owing to their inability to dispose of all the waste products, effete matters remain in the circulation. The blood charged with such materials is less fit to nourish the body, and organs, not at first concerned, become thus affected indirectly, notably the brain and nervous system. Thus indigestion, sluggish and gorged liver, disordered bowels, headache, sleeplessness, plethora, giddiness and irritability are among the earlier results. Gouty and other allied conditions may arise. The evils from excess in animal food are more marked than from excess in vegetable food. Deposition of fat, disordered liver, and so forth, readily arise in the latter, but the retention within the system of the products of nitrogenous excess, introduced to greatest extent in animal food, are more particularly injurious. Whenever, with excess of food, there is deficient exercise, the evils are greatly magnified, and it is under such circumstances that the evils of excessive animal food appear in full force.

Diets suitable for Special Bodily Conditions.

Corpulence, and Banting's System.—William Banting was a London tradesman who, at sixty-six years of age (Aug. 1862), with a height of 5 feet 5 inches, weighed 14 stones 6 lbs. In spite of a most active life, without self-indulgence of any kind, he suffered from what he calls the "lamentable malady" of ever-increasing stoutness. He was compelled to go down-stairs slowly backwards to save the pain of the weight on his ankle and knee joints, and the slightest exertion made him puff and blow. He complains pathetically of the pain inflicted on him in the street or in public assemblies by the remarks of the "cruel and the injudicious." He had "tried sea-air and bathing in various localities, with much walking exercise; taken gallons of physic and liquor potassæ advisedly and abundantly; riding on horseback; the waters and climate of Leamington many times, as well as those of Cheltenham and Harrogate frequently; have lived upon sixpence a-day, so to speak, and earned it, if bodily labour may be so construed." At last he was advised to abstain from all fat and fat-making articles of diet, and in thirty-eight weeks he had reduced his weight by 35 lbs., while in twelve months he had reduced it by 50 lbs., and weighed 10 stones 12 lbs. His original dietary was "bread and milk for breakfast, or a pint of tea with plenty of milk, sugar, and buttered toast; meat, beer, much bread, and pastry for dinner; the meal of tea similar to that of breakfast; and generally a fruit tart or bread and milk for supper." His altered diet was as follows:—

Breakfast at 9 a.m. 5 to 6 oz. of beef, or mutton, or kidneys, or broiled fish, or bacon, or cold meat of any kind except pork or veal; a large cup of tea or coffee (without milk or sugar); a little biscuit or 1 oz. of dry toast; making altogether 6 oz. of solids and 9 oz. of liquids.

Dinner at 2 p.m. 5 or 6 oz. of any fish except salmon, herrings or eels; any meat except pork or veal; any vegetable except potato, parsnip, beet-root, turnip, or carrot; 1 oz. of dry toast; fruit out of a pudding not sweetened; any kind of poultry or game; and two or three glasses of good claret, sherry, or Madeira; champagne, port, and beer forbidden; making altogether 10 to 12 oz. solid and 10 oz. liquid.

Tea at 6 p.m. 2 or 3 oz. cooked fruit, a rusk or two, and a cup of tea without milk or sugar; making altogether 2 to 4 oz. solids and 9 oz. liquid.

Supper at 9 p.m. 3 or 4 oz. of meat or fish, similar to dinner, with a glass or two of sherry and water or claret; making 4 oz. solids and 7 oz. liquid. For night-cap, if required, a tumbler of grog (gin, whisky, brandy, without sugar), or a glass or two of claret or sherry.

The principles involved in this diet are quite evident. The starch, sugar, and fat of the diet are reduced to a minimum. They are, as a matter of fact, less than is sufficient for the liberation of heat and energy. Consequently, the stored-up fat of the body would be drawn upon to yield what was deficient in the diet. In the second place, the richness in nitrogenous material would stimulate oxidation changes, and, aided by exercise, would hasten the consumption of the deposited fat. The diet was successful with Banting, but as a matter of fact it is a modified starvation diet, from its deficiency in non-nitrogenous substances, and many people would find its employment attended by serious results. It is not, therefore, to be hastily tried by everyone with a tendency to stoutness. Its principles, however, may be gradually put in force and extended as the person finds his organization becoming accustomed to them. They are chiefly these: avoidance of all foods rich in carbo-hydrates, or very sparing use of them, notably potato, white bread, rice, sago, tapioca, corn-flour, semolina, sweets, sweet fruits and sweet vegetables—like carrot, turnip, parsnip, beet-root—reduction of fat, butter, cream, and abstinence from sweet wines and ales.

On the other hand, there are allowed all kinds of lean meats, lean fowl, and lean fish, eggs, game, green vegetables, succulent fruits, natural wines, bitter ale in small quantity, and spirits. Brown bread should be substituted for white. It may be added that the large quantity of wines and spirits consumed by Mr. Banting is too great for commendation.

Professor Ebstein of Gottingen has a plan which differs nothing in principle from that of Banting, but which tries to avoid its risks. "Sugars, sweets of all kinds," he says, "I forbid unconditionally. The quantity of bread is limited at most to 3 or 3½ ounces a day, and of vegetables I allow asparagus, spinach, the various kinds of cabbages, the legumes, whose value as conveyers of albumen, as Voit observes, is known to few. Of meat I exclude none, and the fat in the flesh I do not wish to be avoided, but, on the contrary, sought after. I permit bacon fat, fat roast pork and mutton, kidney fat, and, when no other fat is at hand, I recommend marrow to be added to the soups. I allow the sauces as well as the vegetables to be made juicy, as did Hippocrates, only for his sesame oil I substitute butter." "The permission to enjoy certain succulent things, always, of course, in moderation—as for instance salmon, pâté de foie gras, and such like delicacies—reconciles the corpulent gourmet to his other sacrifices. These consist in the exclusion of the carbo-hydrates."

The name of Professor Oertel of Munich is also identified with a cure for "growing too fat." It does not differ in principle from Banting's. But it allows fat to the extent of from 1 to 1¼ oz. per day, and it allows rather more carbo-hydrate, 2½ to 3½ oz. Ebstein allows 3 oz. fat per day, and only 1¾ of carbo-hydrate. Whereas, in Banting's diet, the fat was reduced to ⅓ oz. and the carbo-hydrate to 2¾ oz. per day. Oertel's allowance of albuminous food is nearly the same as Banting's, 3½ to 6 oz. per day, while Ebstein permits only 3½. The feature of Oertel's plan is a series of regular and graded exercises and gymnastics, specially by the enforced exercise of climbing heights.

Diet for Diabetes.—This has been so fully entered into on p. 303 and subsequent pages that further details are not necessary here. It may only be remarked that the diet rigorously excludes carbo-hydrates. The difficulty often is that the excess of nitrogenous diet threatens mischief to the kidneys, and one has to face the question whether a less rigorous exclusion of carbo-hydrates, by necessitating less albuminoid food, may not be less hurtful to the kidney. It is of doubtful advantage to reduce, almost to nothing, sugar expelled by the urine if the method taken to achieve this has lit up a serious kidney disease.

Diet for Gout.—Gout has been sufficiently described on p. 432. One of the chief features in gout is an interference with the due oxidation of proteids, leading to an accumulation in the system of uric acid or urates. The indication, so far as diet is concerned, is the restriction of proteid foods, and especially proteid foods derived from the animal kingdom. Fowl, fish, and milk are quite permissible in the diet, so also are sweetbreads and tripe, if taken in moderation. Of vegetable foods the gouty person should eat liberally—potatoes, carrots, turnips, parsnips, beet, broccoli, Brussels sprouts, cabbage, spinach, endive, lettuce, celery, beans, peas, kale, onions, leeks, salsify, cucumber, marrow, &c. Milk puddings are allowed, if they are made without egg. Custards and omelettes are forbidden, so also are jellies. Pastry is better avoided. Fruit puddings and fruits are suitable. A very small portion of a fat cheese may be permitted, considering its smallness. Of as much importance as the meat is the drink of the gouty person. It would appear as if, in many instances, it is the liquor that is consumed that somehow or other interferes with the proper oxidation of the nitrogenous food and provokes a gouty attack. Malt liquors, all rich and sweet wines, specially port, champagne, &c., are most injurious. Claret, whisky or brandy, and aërated water are the only alcoholic drinks of which the gouty may partake, but always in great moderation. Withal, the dieting is only of great value when combined with regular exercise. If sedentary habits are indulged in, the oxidation of the proteids will still be incomplete, and attacks, though modified, will still recur.

Diet for Rheumatism.—Flesh meat is restricted in rheumatism, and only the lighter and less rich kinds of animal food allowed, such as chicken and fish. Vegetable food is freely given, lemons and lemon-juice being specially commended. The desire is to diminish the acidity of the blood, and this is readily accomplished by a diet poor in animal food and rich in vegetable.

Diets for Invalids.

In the following paragraphs the object is to examine some of the foods which are supposed to be, or actually are, particularly nourishing and digestible, and therefore specially suitable for those whom ill-health has rendered unable to make use of ordinary foods, however light and well-prepared. Without attempting any definition we may say that an invalid has, as a rule, a poor appetite, a weak digestion, and a marked difficulty in making good use of the food that is consumed. So that the indications that ought to be fulfilled by food for invalids is that it shall contain a large quantity of nutritive material, so that even a small quantity shall supply a fair amount of nourishment, that nevertheless it shall not tax the digestion, and that it shall be pleasant and slightly stimulating to the palate. The fulfilment of these conditions is by no means an easy matter. Let us look, first of all, at that preparation, the first and the last resource of the sick-nurse and the detestation (as a rule) of the invalid, beef-tea.

Beef-tea is usually made by cutting up the meat into small pieces, allowing it to steep in cold water for some time, then putting it into a sauce-pan and letting it simmer for some hours. The fluid parts are then poured off, the solid portions, which are tasteless and tough, and, therefore, according to popular notion, valueless, are thrown out. Now what is the value of such a preparation? *As a food it is almost valueless*, and, therefore, does not fulfil the first condition of an invalid dietary. The steeping in cold water extracts the flavouring matter of the meat, the extractives (see p. 537), and the tea has consequently all the flavour of beef, and promotes the delusion that it is nutritive. The cold water extract contains also a fair proportion of soluble albuminoid, but this is coagulated and precipitated by the subsequent prolonged simmering, and much of it is left behind when the fluid parts are poured off. Such a preparation has advantages, no doubt—it is stimulating, invigorating, and is at first enjoyed, though its constant repetition usually brings aversion—*but it is not nourishing*. We have seen that lean beef (for fat meat invalids cannot digest) contains as its principal nutritive material (see p. 543) nitrogenous materials, that is proteids, the myosin of the flesh. If beef-tea is to be worth anything as food it must contain as nearly all of the albuminoids of the beef as is possible. There is only one way of effecting this, and it is by reducing the meat to a pulp, preferably by scraping. Take 1 lb. of lean beef. If it is in one thick slice it will be more easily scraped. Let it be scraped by a knife, and the scrapings removed to a jelly-can. The process is tedious and laborious, and excessively tiring to the wrists. If it is properly done the whole of the red portion of the beef will be reduced to the finest pulp, so fine that when diffused in water it will not be perceptible to the tongue, and the tendinous, fatty, and stringy parts will be left behind, but completely stripped of red flesh. To this pulp in the can add 2 imperial pints of cold water, that is one breakfast-cupful to each $\frac{1}{4}$ lb. of beef, and a very small quantity of salt. Place the jelly-can, uncovered, in a sauce-pan of hot water, put a tight-fitting lid upon the sauce-pan, and place it at the side of the fire for 2 or 3 hours, *never allowing it to become so hot as even to simmer*. It is then kept in a covered vessel and used as required. After standing for a time the meaty pulp settles, so that the whole needs to be stirred before any is removed for use. Of the contents of the jelly-can none is unused. There are no lumps to be removed. The value of this beef-tea can easily be estimated, because it contains all the nitrogenous constituents of the beef, but very little fat. Before being given to the invalid it may be thickened by means of flour, rice, corn-flour, bread-crumbs, &c. Let a tea-cupful be taken in a small pan, and let the necessary amount of rice, corn-flour, &c., be stirred into it, and allow the whole to be very slowly brought just to the boiling point. It is then seasoned to taste. Where rice is used it should be cooked before being added to the beef-tea. The bringing to the boiling point does not injure the meaty portions, when in the form of so fine pulp and when kept from precipitation by the thickening. Now such a beef-tea is of a very fine delicate flavour, not of the strong taste prolonged cooking at a high temperature produces, and the flavour can be modified or entirely altered by the nourishing additions that may be made to it, so that sameness is avoided. Such beef-tea is a true food, it is easily digested because of the fine state of division of the meaty portion and because of the method of cooking, and in the writer's experience it is a most palatable and enjoyable dish.

Two breakfast-cupfuls will contain 107 grains of nitrogen, and probably 150 to 200 grains of carbon, that is not including the value of the added flour, &c.

Liebig's method of preparing beef-tea is as follows:—Half a pound of raw lean beef (chicken or other meat may be also used) is finely minced, placed in a glass or earthenware vessel with $\frac{7}{8}$ths of a pint of water, to which four drops of muriatic acid and half a tea-spoonful of salt have been added. The whole is well stirred and then allowed to stand for an hour. Thereafter it is strained through a hair sieve, and the sieve and residue washed with five ounces water. This is taken cold or only very slightly warmed. It contains not only the extractives, but also a considerable amount of soluble albuminoid, which, if it were boiled, would coagulate. It is not cooked at all, and the raw meat colour, smell, and taste, it possesses sometimes cause it to be objected to. Besides such home-made preparations the invalid has now at command an enormous number of prepared foods, extracts of meat, beef jelly, &c. Nearly all of them possess the qualification of being pleasant to the palate, and easily digested, for most of them contain very little to digest. With one or two noteworthy exceptions, they contain very little real nutriment. All of them are more or less rich in extractives, and thus possess stimulating characters of a high order. But stimulation is not nutrition, any more than blowing with the bellows a low dying fire can be used as a substitute for putting on more coals. The bellows may cause the embers to flare up and burn rapidly, but only the sooner to burn out. It is true that on the low fire one may place plentifully a fresh supply of coal, but it may be so low that it is unable to set fire to the new coal, and so goes out in spite of it. But then if we supply fresh coals and also use the bellows, we shall quicken the dying flame till it has got a sufficient hold of the coal to make it burn briskly without further help. Just so it is of little use to supply a beef-tea which only stimulates and gives no new supply of bodily fuel. If the patient be so weak as not to be able to make use of nourishment without aid, supply the stimulant also, so that the weak energies may be sufficiently roused to benefit by the nourishment. There seems to be no manner of doubt that many persons, exhausted by acute disease, fail to rally when the crisis is past, because they are plied with beef-teas, beef extracts, and so on, under the vain delusion that they are being supplied with nourishment, when they are practically being starved with the smell and flavour of the meat, with its shadow but without its substance.

An excellent example of this is found in the most popular, at least till recently, of all extracts of beef, Liebig's. Each pound of this substance is said to be the "extract" of 45 to 48 pounds of ordinary butcher's meat, and was at first by Liebig himself believed to possess highly nutritive power. Voit, whose name we have so often mentioned in these pages, showed by actual experiment that it failed to maintain life even for a brief season when used as an exclusive diet. This is indicated by its analysis, which shows the chief constituents to be as follows:

Albuminous constituents,	7	per cent (about $\frac{1}{3}$ that of beef).
Extractives, nearly	8	,,
Salts, ...	23	,,

It is, therefore, rich in extractives and salts, to which it owes its flavour and stimulating properties, but poor in nutriment.

A large number of other extracts are not very dissimilar. Valentine's meat juice, made by submitting steak to great pressure, and then evaporating the obtained juice in vacuo to the consistence of syrup, contains, according to the same authority, $6\frac{1}{2}$ per cent of albuminoids, $1\frac{1}{2}$ per cent of extractives, and $11\frac{1}{2}$ of salts. Brand's essence contains over 8 per cent of albuminoid, $\frac{1}{10}$ per cent of extractives, and nearly $1\frac{1}{2}$ of salts. Murdoch's liquid food contains 13 per cent of albuminoids, nearly $\frac{2}{10}$ths extractives, and $\frac{5}{10}$ths salts. Savory and Moore's fluid beef possesses 8 per cent albuminoid, $7\frac{1}{2}$ of extractives, and 12 of salts. A great improvement on these, from the nourishing point of view, are Johnston's fluid beef and Kemmerich's extract of beef; the former of which contains 35 per cent of albuminoids, $1\frac{1}{2}$ of extractives, and 15 of salts, while the latter shows 22 albuminoid, 6 of extractives, and $18\frac{1}{2}$ of salts.

Now the difficulty of getting the nutriment of the beef into extracts such as these is the difficulty of solution. The nutriment becomes insoluble with a high temperature such as is employed in the manufacture of most of them. One recent method of getting over this difficulty is by the use of artificial digestive agents, which convert the albumin into the form of peptone, which is soluble and not precipitated by heat. This is done by allowing the meat to be acted on by pepsin or pancreatin, both digestive agents, and then making an extract of the soluble parts. This has for invalids a double advantage. It makes the extract more nutritious, and since the albumin is either wholly or partially digested, it passes easily into the circulation without trouble to the weak digestion of the patient. Of such peptonized food or peptones there is now a great variety. Savory and Moore supply a dry meat peptone which can be conveniently added to other food. Peptonized beef jelly, peptonized chicken jelly, peptonized cocoa and milk, and so on, are made by them and other chemists. Many of them are still deficient in nutriment, and yet more valuable than the ordinary extracts. Benger's peptonized beef jelly contains over 4½ per cent of peptone, and 2½ other albuminous substances. But chief of all such foods, in the writer's opinion, is Carnrick's beef peptonoids. It is in the form of a dry powder, containing only 6¾ per cent of moisture. It contains no less than 63½ per cent albuminoid, of which 7 per cent is peptone. Besides it contains 10½ per cent fat, and 5½ salts. The makers assert it to be made of beef, reduced to powder, and fine wheat flour and milk dried to a powder. Of its highly nutritious qualities there is no possibility of doubt. Its only disadvantage is a not too agreeable flavour, which is, as a rule, not enjoyed by invalids. But then the powder may be mixed with hot water, as cocoa is, and seasoned to taste. If advantage is taken of the pleasant flavour of Liebig's extract, and a small quantity stirred in with the Carnrick's powder, a highly nourishing, pleasant, and stimulating fluid food is obtained. It can also be stirred with milk and used in other ways.

Anyone can now also prepare peptonized foods for invalids by using the pepsin powder, or pancreatin, or the liquor pepticus, or liquor pancreaticus, obtainable from every chemist. Milk, beef-tea, soups, &c., can be so peptonized before being given to invalids. All that is necessary is to bring the milk, beef-tea, &c., to a lukewarm temperature, then to stir in the powder, or liquid—pancreatin or liquor pancreaticus would be best—and keep the mixture warm for half an hour or thereby. With any of the preparations now in the market full directions can be obtained, so that no one need be at a loss how to proceed. (See below.)

The less nutritious forms of extract may still be of great value in the dietary of invalids, provided always people will remember that they are not to take the place of foods, but are to act as stimulants and excitants to appetite and digestion. They are to be used only as food adjuncts. If they are used simply to stimulate the taking of other and nutritious food, supplied with them, they will be used in their proper place, and will be of great value. If they are permitted to form the main diet of the invalid, the unfortunate will starve.

Diets for Infants.

Sufficient has been said elsewhere, in previous pages, as to appropriate diet for infants and young children. The object of these paragraphs is to point out the nature of a few of the foods offered now in great variety in the market as substitutes for mother's milk.

If mother's milk be taken as a standard, then infants' food should contain 1 of nitrogenous to every 3 non-nitrogenous constituent (see p. 615), or 1 of nitrogen to every 13 of carbon. The best known of such foods are Savory & Moore's, Nestlé's, Ridge's, Mellin's, Neave's, Carnrick's, and Benger's. The proportions of the two kinds of constituents are as follows:—

	Nitrogenous.		Non-nitrogenous.
Carnrick's	1	to	4½
Neave's	1	,,	5½
Franco-Swiss Co. Milk Food	1	,,	6½
Savory and Moore's	1	,,	7
Benger's	1	,,	7½
Nestlé's	1	,,	7½
Ridge's	1	,,	9⅓
Mellin's	1	,,	9½

In many of them not only is the proportion of non-nitrogenous material too high, but it consists largely of starchy material not easily digested by the child, and too little in the shape of fat (like the butter of milk) and sugar. In Ridge's this insoluble form of carbo-hydrate exists to the extent of over 78 per cent, in Neave's 73 per cent, in Savory & Moore's 70 per cent, in Benger's nearly 66 per cent. In Carnrick's it falls to 41½, in Nestlé's 35½, in the Franco-Swiss Company's to 37½, and in Mellin's to 18½; but Mellin's and Nestlé's, and we may say also the Franco-Swiss Company's, are too poor in nitrogen. In the matter of infants' food, also, analysis seems to show Carnrick's to be superior to the others. It contains 5 per cent of fat, Nestlé's 4½; all the others contain scarcely 2 per cent, and Mellin's barely 1 per cent. Therefore we give it as an opinion, based upon the proportion of nutritive ingredients, that Carnrick's soluble food comes nearer to what an infant's food should be than any of the others.

Besides in the form of such prepared foods, there are now other methods of administering foods to delicate children of a very reliable character. Cow's milk sometimes disagrees with children, because it forms a large curd in the stomach in process of being digested. If boiling the milk does not prove a satisfactory method of overcoming this difficulty, partially digesting the milk will. For this purpose peptic or pancreatic juice may be added to the milk, and the milk then allowed to stand for half to three-quarters of an hour in a warm place. It should not be allowed to stand too long, lest a bitter taste is developed. The peptic or pancreatic juice partially digests the casein of the milk, so that when swallowed it no longer curdles in large masses. The most reliable forms of such juices are Savory & Moore's of London, or

Benger's of Manchester. A very convenient means of predigesting milk or other food-stuff, such as home-made beef-tea, &c., is supplied by London chemists, Burroughs, Welcome & Co., in the form of peptonizing powders. They are in little tubes, each containing some pancreatin and carbonate of soda, enough for 1 pint of milk. It is advised to add $\frac{1}{4}$ of a powder to $\frac{1}{4}$ of a pint of milk diluted with a $\frac{1}{4}$ pint of cold water. The glass containing the mixture is made to stand in another vessel containing water as hot as the hand can bear for 10 to 20 minutes, before the mixture is given to the child. If it is not to be given at once, the mixture is, after the lapse of twenty minutes, brought to the boiling point to prevent further action of the ferment, which, otherwise, would go on acting, and would produce a bitter taste. By such predigesting of milk—and, as already said, any other food-stuff may be similarly acted on—serious digestive troubles may be overcome.

THE PRESERVATION OF FOOD.

In the first part of this book, in Section XIII. (p. 384), it has been shown in great detail how putrefaction and decay are the work of living organisms or germs deposited from the atmosphere, which, however, can be destroyed, or whose work can be prevented, by various means. The part played by such organisms in the economy of nature has also been indicated (p. 390). The living agents of putrefaction perform, we have seen, an indispensable work in the cycle of natural processes, whereby the lifeless, and in that condition useless, organic mass is resolved into its inorganic constituents, with their endless possibilities of reconstruction and revivification. But, from a human point of view, their range of operation is too unlimited, their attack too rigidly impartial, too universal, too regardless of the fitness of things, humanly speaking. For a large and necessary element in man's food is organized material readily surrendering to the attack of germs. Man's wanderings on the earth are not conditioned mainly, as are those of lower animals, by the quest of food, nor is the population of different regions determined by the abundance or scarcity of provision. Rather, indeed, as the population increases does the capacity of that region to maintain its inhabitants diminish. Thus it early became a question whether food could be preserved from the inroads of putrefaction, to permit of its transport from the place of abundant supply to the place of scarcity, and whether food, to be obtained in abundance only at one season, could be preserved to the season of scarcity. It must have been early observed that moisture and heat were two conditions necessary for putrefaction, and that the absence of these conditions favoured preservation. The natural preservation of grain must speedily have shown this, and the application by man to fruits, like grapes and currants, could not long be delayed. It appears, moreover, that this process had long ago been applied to animal food, for in the British Museum there are to be seen specimens of dried poultry, taken from Egyptian tombs, which are supposed to have been placed there thousands of years ago. **Tasajos** and **charqui**, or jerked beef, are varieties of meat prepared in South America by drying, after being dipped in brine. Similar to these is the **beltong** of the Kaffirs and the **pemmican** of arctic voyagers, the latter consisting of fat as well as of the red flesh and being also mixed with sugar and spice. In France in 1386 dried yolks of eggs were pounded and stored in barrels as provision for the army. In recent days similar methods have been applied to vegetables, potatoes, cabbage, carrots, cauliflowers, &c. The drying process, however, at least as applied to beef, seriously affects the meat so far as its nutritive qualities are concerned, and renders it tough, difficult of being cooked, and not easily digested. The practice of embalming shows also that the ancients understood that the decay of animal bodies could be prevented by chemical means, while the custom of swathing bodies in waxed and resinous bandages and inclosing them in leaden coffins, shows that they had some idea that atmospheric air was a principal agent in producing the putrefactive change. Nature herself indicated the power of cold to arrest decomposition. In Russia and other northern countries it is a common custom to kill fat cattle in November, when fodder grows scarce, and bury them in the ice or frozen earth till the beginning of May, and to pack poultry in tubs with layers of snow between them. The value of cold as a preserving agent was brought prominently before the public mind by the discovery of the mammoth at Jacutsk in Siberia, in a perfect state of preservation, embedded in a block of ice upwards of 200 feet high, an animal whose structure indicated its belonging to long bygone ages, and by the recovery in 1861 of the bodies of three Chamounix guides who had been carried away from the grand plateau of Mont Blanc by an avalanche forty-one years before.

So that the preservation of food by drying, by chemical means, by the exclusion of air, and by the use of cold, might almost be considered as parts of ancient history. Yet no method seems to have been extensively adopted till quite recent times. But with the development of ocean navigation and voyages of discovery the necessity of adopting some reliable methods became the spur to invention. The method of drying was too coarse in its results, and chemical means were not desirable, from the point of view of the palate. Salt, used for such purposes from the earliest times, which rendered the meat hard and indigestible, as well as less nutritious by extracting some of the nutritive juices of the meat, proved itself to possess more fatal objections to the long voyager, when out of an expedition of 961 men, 626 were lost by scurvy, the attendant of a diet too abundant in salt junk and destitute of fresh provisions. How urgent became the demand for better methods is evident from the fact, that while in the seventeenth century only one patent for the preservation of food was described, and only three in the eighteenth, as many as 117 were specified in the first fifty-five years of the present century, and since then they have been very numerous. Some of these were for drying processes, such as that by which Liebig's extract of meat, Hassal's flour of meat, Blumenthal and Chollet's meat and vegetable tablets, &c., are prepared; others were for chemical processes, such as the employment of sulphurous acid or carbonic oxide gas, or the injection of meat with chemical agents. The chief patents, as now appears, were those which proposed to exclude the atmospheric air or to employ cold. One method (Plowden's, 1807) proposed to exclude the air by incrusting the meat with some substance which would resist the action of the air, and the substance used was a hot extract of meat; another proposed to coat the meat with impermeable varnish. These failed, and we now know the reason. It is not the air in itself that effects the noxious change, but the living germs deposited from it. These already would be deposited on the meat before the coating was applied, and under cover of the impermeable coating could calmly proceed about their ravages. Augustus de Heine, in 1810, proposed to place the food in closed vessels and then to withdraw the air through a valvular aperture by a special exhausting apparatus. That method, too, was found to fail for similar reasons. In 1807, however, T. Saddington, of London, proposed to preserve fruits without sugar, by placing them in bottles, *driving air out the bottles* by heat, filling them up with boiling water, and then tightly corking them. The bottles, filled with fruit to the neck, were placed in a water-bath, the water of which was gradually heated up to 170° Fahr. Then the boiling water was poured in. For his method Saddington received a premium from the Society of Arts. Three years later, in 1810, a Frenchman, Appert, applied the method to meat, vegetables, fruit and milk, receiving as the reward of his labours 12,000 francs from the French government. Appert first partially cooked his provisions. He then placed them in strong bottles which he filled up to the neck. The bottles were then well corked, and the corks were covered with a luting of cheese and powdered lime, which he said rapidly hardened and was then able to resist the action of boiling water. The bottles were then wrapped in coarse canvas bags and placed up to the neck in a boiler of cold water. The boiler was covered and heat applied till the water boiled. It was kept boiling for an hour or more. The heat was then withdrawn, the water drawn off, and the bottles allowed to cool. "In every case," says Appert, "the exclusion of air is a precaution of the utmost importance to the success of the operation; and in order to deprive alimentary substances of contact with the air, a perfect knowledge of bottles and the vessels to be used, of corks and corking, is requisite." It is interesting at this date, and with our modern views, to read the notions that prevailed in the days of Appert. The alimentary substances were heated to drive the air out of the vessels that contained them. But to get rid of the last trace of air was a practical difficulty, and prolonged boiling was resorted to with the idea that the animal substance was thereby so altered as to render it less disposed to putrefactive change, while, at the same time, it was supposed that any of the oxygen of the air remaining in the closed vessels was thus destroyed. Thus we are told "the heat acts by indisposing the substances from entering into chemical action, and by removing all risk of ill effect from the small portion of air which the vessels may contain; while the rigorous exclusion of the external air contributes to render permanent the state into which the substances have been brought by the temporary application of heat."

Now, though Appert's method has proved of immense practical value, his explanation of it has been proved quite erroneous. For, as has been shown (p. 386), air may be admitted in abundance to organic solids and fluids without exciting putrefaction, provided the organic impurities have been previously removed from the air by filtration, and substances which have been submitted to the operation of boiling are as eligible sites for the work of decomposition as those that have not been boiled. It is not the oxygen of the air that is the exciter of putrefaction, but the living organisms. It was not the expulsion of air produced by the boiling, for even that was not properly effected, that preserved the food-stuffs, it was the destruction by the heat of the living things; and it was not the continued exclusion of the air in itself, by sealing, &c., that maintained the preserved condition, but the barrier thus set up to the access of a new supply of active organisms. Enormous quantities of all sorts of alimentary substances are now preserved for indefinite periods by methods similar to that of Appert, greatly improved in its details. The substances to be preserved are packed in tins; a small quantity of water is added. The covers are carefully soldered on the tins, and in each cover is made a small pin-hole. The tins are then placed up to a short distance from the covers in "baths" of water, to which chloride of calcium has been added. The addition of the chloride raises the boiling point to between 260° and 270°, and thus ensures a greater degree of heat than could be obtained by water only. The bath is kept boiling for some time till the issue of steam from the pin-holes ensures the expulsion of air from the tins. Solder is then dropped on the pin-hole and the tins thus tightly sealed. They are then completely immersed for some time in the hot bath, and after being removed are placed in chambers kept at the degree of temperature most favourable to putrefaction. There they remain for some time. If decomposition ensues in any of the tins, it is evidenced by the bulging of the sides owing to the pressure of the gases of putrefaction. If the food remains sound, the top and bottom of each tin should be concave, pressed inwards by the atmospheric pressure outside and the diminished pressure, owing to the partial vacuum, within. If the soldering gives way at any part of the tin, or if, in course of transit, by bad usage, and so on, a crack be opened in the casing, or a point of a nail driven in, or if, by the action of weather, damp, &c., the paint coating of the tin having become rubbed off, the metal has been eaten into, air will effect an entrance with a rush, carrying germs of putrefaction with it. Thus a tin apparently sound may, on being opened, reveal putrid contents. Search will likely discover the secret pathway of the enemy. That the process is, however, an eminently satisfactory one, so far as preservation is concerned, is shown by the fact that stores of tinned meats, landed on the beach of Prince Regent's Inlet from the wreck of H.M.S. *Fury* in 1825, were found twenty-four years later in a perfect state of preservation by the captain of H.M.S. *Investigator*, and that in spite of exposure to extremes of weather. The extent of the industry which has been developed, aided by various modifications and improvements in the process, is of a very remarkable character. For the following statistics in reference to the industry I am indebted to the kindness of Messrs. Simpson, Roberts, & Co., of Liverpool and Halifax.

In 1885 21,255,000 pounds weight of tinned meats were imported into the United Kingdom from Australia, the value of which was about £430,000. On the Pacific Coast of North America the tinning of fish, principally salmon, is a large industry, the amount packed in 1884 being 47,294,160 in tins of one pound, and in 1885 the amount was 40,114,320 one-pound tins. Of these one-pound tins from seventeen to nineteen millions are imported into the United Kingdom annually to cheapen our fish supplies.

Messrs. Simpson, Roberts, & Co. also inform me that an average of 50,000 one-pound tins of canned salmon are consumed daily in this country, 35,000 of lobster, and probably 100,000 of beef and mutton. In Australia the industry is conducted at 19 factories, of which 4 are in Queensland, 5 in New South Wales, 4 in Victoria, and 6 in New Zealand, and the work is performed mainly by Scotchmen or men of Scotch descent, to the number of 2500 to 3000 persons. In Canada the Scotch villages on the coasts of Nova Scotia, Cape Breton, and Prince Edward Island furnish the bulk of the fishermen, and packing men, women, and girls. In many fishing villages in Nova Scotia and Cape Breton Gaelic is still found, and in many it prevails. With the Scotch villages are found French communities, which furnish clever-fingered females for the careful and tasteful filling of the lobster cans. In many instances the parish priest conducts the business arrangements of the simple Franco-Canadian peasants, and inspects during the season the conduct and progress of his flock. The value of the industry to the fishing community of Canada and Newfoundland amounts to from £250,000 to

£300,000 annually. So energetically has the fishing been pushed that the supply has rapidly diminished for two or three years past. Six years ago two or three lobsters filled a one-pound can, but in 1885 over five were necessary. Restrictive laws under such circumstances seem absolutely demanded. On the Columbia, Oregon, and neighbouring rivers the salmon fishing is carried on by white men, and the canning by Chinese labour, but in British Columbia to the north both are conducted by whites, though the Chinese are expert, cleanly workers, and more economical. In Scotland large businesses are carried on in Aberdeen, Dundee, and Leith in the preservation of meat, fish, &c.

This canned goods industry has thus, within comparatively recent years, assumed enormous proportions, and has become of vital interest to considerable populations. There can be no doubt, however, that the industry might become even more extended but for the fact that, by the methods employed, the meat is constantly overcooked, and to that extent not so much relished by the people. So far as one can gather all this superheating is for the purpose of expelling the last traces of oxygen not only from the tin but from the tissue itself. Many of the comparatively recent patents have been taken out because of some new modification that would ensure this more completely. Now it is fifty years since scientific investigators showed that the notion that the oxygen of the air was the cause of putrefaction was a delusion, yet this mistaken idea guides the practice of an industry which has practically developed since that time. The scientific facts tend resistlessly to the conclusion that absurdly high temperatures are employed in the canning process, and that the alimentary substances are exposed to them for unnecessarily long periods. I cannot resist the conclusion, from a careful survey of the facts, that if, to the undoubtedly high degree of perfection to which the mechanical portions of the operations of canning have been brought, some acquaintance of recent scientific advances in knowledge and in methods were added, some simple modifications of the process would be found, which would permit of the employment of a much lower degree of temperature, without interfering with the thoroughness of preservation.

Within recent years the agency of cold has been invoked on a very extensive scale for the preservation of food. A patent was taken out by John Lings in 1845 for employing ice in closed chambers to reduce the temperature to the proper degree. If a sufficient degree of cold is obtained the activity of the organisms of putrefaction is arrested, though the organisms are not destroyed. On the restoration of a normal temperature they become as active as ever. Following Ling's patent, others were taken out for obtaining the requisite low temperature by the evaporation of ammonia and ether. The invention of machines for the artificial production of ice gave an impetus to the employment of ice for preserving food for considerable periods. During the winter of 1875–76 large quantities of beef, mutton, and pork were brought from America preserved by ice. An effort made in 1873 to bring meat from Australia, preserved in this way, failed because the supply of ice gave out before the end of the voyage. It seemed as if there was little prospect of a trade in fresh meat being opened up between this country and so distant quarters of the globe as Australia. But in 1879 Mr. J. J. Coleman of Glasgow went out to New York with a Bell-Coleman air refrigerating machine, and proved that food could be preserved for long periods by the agency of air cooled by mechanical means. This Bell-Coleman machine is a remarkable example of the practical working out of advanced scientific theory. Its construction is based on the principles of thermodynamics, that when air is compressed heat is evolved, and that, if this compressed air be then allowed to expand, and be caused, in the act of expansion, to do work, a large amount of heat disappears. The machine, worked by steam, sucks in a certain quantity of air and compresses it to a pressure of 50 to 60 pounds to the inch. The air in the act of compression becomes very hot; it is cooled by the injection of cold water. The cold compressed air is now dried by being passed through a set of horizontal pipes, and is then allowed to expand behind a piston, which it propels in the act of expansion. In the act of doing work the expanding air becomes cooled, "as much as 50, 100, and 200 degrees below freezing point, according to the amount of previous compression." The cooled air is passed into the chamber containing the provisions, and the temperature of the air in the chamber can be kept by the machine at a constant low temperature for any length of time. With such machines no previous packing of the meat is required. The carcasses are cut up into quarters or other convenient sizes, placed in calico bags, and packed in the freezing chamber. Up to the beginning of 1883 about 4000 tons of frozen meat were delivered in Great Britain from Australia and New Zealand, preserved by the cold-air machines. As an example the following may be taken. The sailing ship *Dunedin* left Port Chalmers on the 15th February, 1882, and arrived at London Docks after a passage of 98 days. She brought 4909 carcasses of sheep and 22 pigs, all in excellent preservation, in a chamber kept cold by a Bell-Coleman machine. The sheep had been killed on the estate of the New Zealand and Australian Land Company, and were brought to the ship from a distance of sixty miles. They were hung up in the freezing chamber, and, when frozen hard, were wrapped up in calico bags and packed in layers in the lower chamber of the ship. They realized in London over £4200 more than was necessary to pay all expenses, which was equal to over 3 pence per pound for the mutton. According to the Smithfield Market reports, 27,007 tons of mechanically cooled meat, chiefly beef, arrived from the United States of America in 1884. In 1885 the total quantity of mutton received in this way from the colonies of Australia, New Zealand, and the River Plate was 777,891 carcasses, which weighed 21,930 tons.

Cold preserves meat simply because, at a low temperature, putrefactive and other germs are inert. They are not destroyed, but simply dormant, and when a normal temperature is restored they renew their activity. It has been noticed that frozen meat spoils more quickly after it has been thawed than ordinary meat. This is probably due to the fact that the process of freezing separates out water which formed part of the tissues, and that, on thawing, the water is not taken up again into the substance of the tissues, but remains simply moistening them. The meat being thus in a more moist and soft condition, permits of more rapid development and propagation of organisms. If frozen meat be thawed very slowly, however, the moist condition is not so marked, and the meat will remain longer in good condition.

Recently Mr. Coleman, in conjunction with Prof. M‘Kendrick, investigated the question whether an extremely low temperature of 150° below zero or thereby, which can readily be obtained by a Bell-Coleman machine, would not absolutely destroy living organisms. They answer the question in the negative. Micro-organisms submitted even to such a low temperature as that became as energetic as ever when warmth is restored. Had the question been answered in the affirmative, it is easy to see what a new and valuable addition would have been made to food-preserving methods. It would then have been possible to seal up *fresh uncooked* meat in tins, and after a period of exposure to the extremely low temperature, to keep it, as cooked food is now kept, in tins, without any other precaution, for indefinite periods.

SECTION II.—DRINKS.

Water.

- The Composition of Water.
- The Physical Properties of Water:
  - *The Density of Water*—Its Relation to Temperature;
  - *Latent Heat and Capacity for Heat of Water;*
  - *Water as a Solvent.*
- The Constituents of Water:
  - *Solid Constituents of Water*—Cause of Hardness in Water, and the Means of Softening Hard Waters;
  - *Gases Dissolved in Water.*
- Impurities in Water:
  - *Organic Impurities;*
  - *Gaseous Impurities;*
  - *Metallic Impurities*—Lead, &c.
- The Various Kinds of Water:
  - *Distilled Water*—Its Action on Lead;
  - *Rain Water*—Its Constituents Dependent on the Atmosphere through which it falls;
  - *Ice and Snow Water;*
  - *Well Water*—The Relative Purity of Shallow and Deep Well Water;
  - *Spring Water—Artesian Wells;*
  - *River Water—Lake Water—Sea Water.*

The Detection of Impurities in Water:
- *The Detection by Colour, Odour, and Flavour;*
- *Tests for Organic Impurity*—Nessler's and the Permanganate Test—How to Employ Them—The Meaning of Albuminoid Ammonia;
- *The Detection of Lead;*
- *The Microscopic Examination of Water*—Living Organisms in Water.

The Purification of Water:
- *Filtration and Filters for Domestic Use;*
- *The Clarification of Water by Alum, Oak Chips, &c.;*
- *Purification by Condy's Fluid.*

Impure Water as a Cause of Disease.

Aerated Waters:
- *Carbonic Acid Gas*—Its Preparation and Properties;
- *Soda Water—Potash Water—Lithia Water—Lemonade and Gingerade;*
- *Oxygenated Water;*
- *Contamination of Aerated Waters.*

Tea, Coffee, Cocoa, Chocolate.

Common Features of Tea, Coffee, &c.:
- *The Active Principles of Tea, &c.*—Thein, Caffein, Theobromin;
- *The Essential Oil and Astringent Principle of Tea, &c.*—Tannin in Tea.

Tea:
- *Its Characters and Method of Preparation;*
- *The Composition of Tea;*
- *The Value of Tea as a Food-stuff*—Constituents of a Cup of Tea;
- *Adulterations of Tea.*

Paraguay Tea or Maté and Bohemian Tea.

Coffee:
- *The Composition of Coffee;*
- *The Action of Coffee*—Constituents of a Cup of Coffee;
- *Chicory—Coffee Leaves.*

Cocoa:
- *The Preparation of Cocoa*—Cocoa-nibs—Chocolate;
- *The Composition of Cocoa;*
- *The Value of Cocoa as a Food-stuff;*
- *Brazilian Cocoa or Guarana.*

Coca or Cuca.

The Kola-nut.

Alcoholic Drinks.

Alcohols:
- *The Composition of Alcohol*—Wood Spirit—Spirit of Wine—Potato Spirit or Fousel Oil;
- *The Preparation of Alcohol*—Malting—Fermentation—Distillation—Rectified Spirit—Absolute Alcohol—Proof Spirit;
- *Proportion of Alcohol in various Spirits;*
- *Brandy and Whisky;*
- *Rum—Gin—Arrack;*
- *Liqueurs*—Absinthe—Curaçoa—Benedictine—Noyeau—Maraschino—Kirschwasser—Chartreuse;
- *The Effects of Alcohol on the Body*—Is Alcohol a Food?—Its Value in Disease.

Wines from the Grape:
- *The Preparation of Wine*—Dry Wine and Sweet Wine;
- *The Composition of Wine*—Plastering of Wines;
- *The Use of Wines;*
- *The Adulteration of Wines.*

Wines from Fruits other than the Grape:
- *Cider and Perry;*
- *Gooseberry Wine, &c.*

Beer and Malt Liquors:
- *The Preparation and Composition of Beer and Stout*—Lager Bier—Weiss Bier—Ginger and Treacle Beer.
- *The Nutritive Value of Malt Liquors.*

WATER.

Composition of Water.—Water, up to the year 1782, was considered a simple substance, but about that year the Honourable Henry Cavendish showed it to be a compound body, formed of the union of two gases, oxygen and hydrogen. He showed that when these two

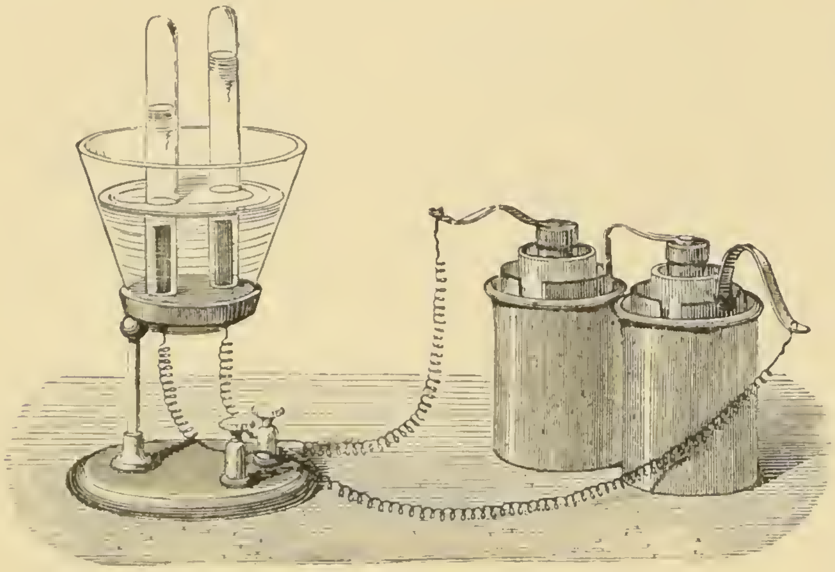

Fig. 257.—Apparatus for Decomposition of Water.

gases, mixed in a certain proportion, were caused to enter into chemical union by the agency of the electric spark, drops of moisture were formed on the inner surface of the vessel. The French chemist, Lavoisier, confirmed this observation by a reverse process, namely, by splitting up water into the two elements of which it is formed. When an electric current is passed through water contained in a tube, such as is shown in Fig. 257, the water is decomposed into its elements, which appear as bubbles of gas at the terminals or poles of the wire. One gas is given off at the positive pole, namely, oxygen, and collects in that end of the tube, the other gas, hydrogen, is given off at the negative pole, and is collected in that limb of the tube. If this experiment be performed, it will be noticed that the gas which collects on the side of the negative pole is twice as much as that which collects on the other side. Moreover, if an accurate experiment be made as to the union of the two gases in the formation of water, it is always found that twice the bulk or volume of the hydrogen is required to combine with a given volume of oxygen. If more than twice the volume of hydrogen is supplied when the union is effected, the excess of hydrogen will be found uncombined. If less than twice has been supplied, some of the oxygen will be found uncombined. Always twice the volume of hydrogen, neither more nor less, unites with a given volume of oxygen to form water, and thus the chemical formula representing water comes to be H_2O, indicating the facts that have been stated. But while two *volumes* of hydrogen unite with one of oxygen, the quantity of hydrogen is not twice the *weight* of the oxygen. For if a volume of hydrogen be taken, say a large enough bulk of it to weigh 1 lb., if an equal volume of oxygen were weighed it would be found equal to 16 lbs.; that is, oxygen is sixteen times heavier than hydrogen. Two pounds of hydrogen then unite with sixteen of oxygen, or the proportion by *weight* is 1 to 8. If then 1 pound weight of hydrogen were caused to unite with 8 pounds weight of oxygen, the result would be 9 lbs. weight of pure water. Such a thing as absolutely pure water is not, however, known. For even when pure oxygen and pure hydrogen have thus united to form water, the contact of the water with the sides of the vessel, glass, iron, &c., robs it of its absolute purity, for it would derive some minute trace of earthy matter from its touch. Distilled water contains some traces of earthy matter. Moreover, water has not only the power of dissolving solid substances, but it also dissolves gases. So that water exposed to the atmosphere takes up into solution appreciable quantities of the oxygen and nitrogen, which, in mechanical mixture, form the common air, and also of other gases, such as carbonic acid gas, which is always present in the atmosphere. Water, as we know it, always contains gases in solution, and contains also solid matters in solution, the nature and quantity being dependent upon the channel along which the water has flowed, if it be taken from a river, or the soil through which it has passed, if it be from a spring, and so on. "Pure water" is, therefore, a phrase used merely relatively, and is applied to water which possesses only such natural ingredients, in small amounts.

Physical Properties of Water.—Within a certain range of temperature, at the ordinary pressure of the atmosphere, water remains liquid. The range of temperature is, on the Fahrenheit scale, between 32° and 212°; at the former the water becomes solid, at the latter it becomes converted into vapour.

Density.—Connected with these two transformations are some extremely remarkable facts. All bodies expand and become less dense on heating, and contract, becoming more dense, on cooling. Water follows this rule only to a certain extent. On cooling its density gradually increases till a temperature is reached of $39\frac{1}{5}^{\circ}$ Fahr. That is to say, up to this point, in a pond or lake, let us say, in cold weather, the water will undergo a process of mixing. As the water on the surface is cooled down by contact with the cold atmosphere, it becomes more dense, sinks, and allows warmer water from below to rise to the surface, which in turn becomes cooled, sinks, and so on. Now suppose the cold were intense and long enough continued, this process might go on till the whole mass of water in the deepest lake, or sea for that matter, were reduced to the freezing point, so that the lake or sea would become frozen to the bottom, and all fish would perish. The remarkable fact, however, is that at the temperature of 39⅕° F., water has it maximum density. If the temperature falls below that point the water ceases to follow the rule and begins to expand, and continues to expand till the freezing point is reached. A vessel filled to the point of overflow with water at 39⅕° will immediately begin to run over, if the water is further cooled, because of the expansion. It is this that causes water-pipes to burst in time of frost. The effect of this on lakes, &c., is that as soon as the water on the surface becomes cold enough to be on the point of forming ice, it is of less density than the water below, and remains upon the surface. It is also a bad conductor of heat, and so it serves as a protection between the freezing atmosphere and the warmer water beneath, preventing the mass of water freezing throughout.

Latent Heat and Capacity for Heat.—A second remarkable fact is that in the transformation of water from the liquid to the solid state, a large amount of heat is liberated from the water, and when the solid ice is retransformed into liquid water, a disappearance of heat takes place to the same extent. This may be easily understood by a simple experiment. If ice be placed in water in a pot, and set on the fire, it will, of course, melt. If the temperature of the mixture be taken it is 32° F., and when the pot has been on the fire sufficiently long to cause the ice to be nearly all melted, if the temperature be again taken, it is still 32° F. A large amount of heat has disappeared, or has become "latent," as the phrase is, in the act of melting the ice. The quantity of heat which thus disappears or becomes latent in melting the ice would be sufficient to raise the temperature of 1 lb. of water from freezing point up to 174° F.

A similar thing happens when at the boiling point water becomes converted into vapour. The temperature of boiling water and of the vapour given off is the same, and yet a large amount of heat disappears in the transformation of the liquid to the gaseous condition. The heat which thus becomes latent is called the latent heat of vapour, and is so great that the heat which disappears in converting 1 lb. of water into vapour would raise the temperature of over 5¼ lbs. of water from freezing to the boiling point. In other words, 1 lb. weight of the vapour of water at the boiling point, if mixed with 5¼ lbs. of water at the freezing point, would make the water boil. It is this fact that makes it possible for one to boil water in a capsule of paper. So long as there remains any water in the paper it will not burn, for the temperature cannot rise above 212° till all the water has been converted into vapour, and this temperature is not sufficient to set fire to the paper. It is the same fact that makes steam so valuable an agent for heating purposes. For in passing back again from the condition of vapour to that of water, this enormous quantity of heat is liberated, and may be used to heat the atmosphere. In passing from the liquid to the gaseous state water expands enormously; the vapour given off from one pound of water will occupy a space 1600 times greater than that of the water; hence arises the energy of steam-engines.

It may be noted here that the vapour of water is quite colourless. It is only when the vapour passes into a colder atmosphere and begins to condense that it becomes visible as steam, or as fog, cloud, &c.

It is, moreover, the operation of the same fact in nature which prevents sudden changes likely to be destructive alike to the life of plants, animals, and man. Just as the passing off of the water, boiling in a paper-bag over a flame, into steam saves the paper from destruction, so is the earth saved from bursting into fervent heat under the influence of a hot sun by the evaporation of water from its surface, and from river, lake, and ocean. Even so is the human body saved from destruction by fire, by the fire of the combustion process going on within itself. For it has been estimated that the heat given off within the body by the oxidation of food is sufficient in 24 hours to raise the whole body to the boiling point. The evaporation of sweat from the body causes the disappearance of an enormous quantity of heat, and thus keeps the temperature at a normal level (see p. 309); on the other hand, if the passage of ice to water did not involve a large absorption of heat, a few hours of a hot sun would convert masses of snow on mountain ranges, or ice-glaciers, into torrents carrying destruction to the valleys. But the physical facts that have been stated show how the inevitable and unceasing operations of nature, as they apply even to such an apparently simple substance as water, substitute gradual changes for sudden reversals, and combine for the comfort and continuance of the living creation. A kindred fact to that of the latent heat of water is what is called the capacity for heat of water. Suppose a quantity of lead to be placed in a pan over a fire, and the same weight of water placed in a similar pan over the same fire, the lead will become hot long before the water, because the lead has much less capacity for heat than water. This is represented in figures by saying that the capacity of water for heat in comparison with lead is as a 1000 compared with 31. To put it in another way, one could heat 32 pounds of lead to a certain degree as quickly as 1 pound of water to the same degree. Our seas, lakes, rivers, &c., become warm more slowly than would similar masses of any other substance, and they cool also more slowly, and in this way also they are natural opponents of sudden change, and are important agents in securing gradual changes of season, and in tempering alike the fierceness of summer and the rigour of winter.

The boiling point of water is 212° F. at the atmospheric pressure represented by 30 inches of mercury. If the pressure falls, as it does when one ascends in the atmosphere, water will boil at a lower temperature. Thus when the pressure falls to nearly 28 inches, water will boil at 209° F. On the top of Ben Nevis, in Scotland, 4406 feet above sea-level, the boiling point is reduced to 203°, equal to a barometric pressure of a fraction above 25 inches. If the pressure be increased, as it is if one descends a pit, the temperature of boiling rises. Moreover, the pressure of dissolved salts in water raises the boiling point. Thus common salt, to the amount of 7·7 per cent, will raise the temperature nearly 2°.

Water as a Solvent.—Water is one of the most efficient of solvents, dissolving solids, liquids, and gases, though in very different proportions: thus 1 lb. weight of cold water will dissolve 3 lbs. of cane-sugar, but the same quantity of cold water will dissolve not much more than ⅓d lb. of common salt. Hot water usually dissolves substances more readily than cold, though this is not always so. For water at the point of freezing will dissolve twice as much lime as water at the boiling point. Gases are dissolved in water very readily, some, however, much more readily than others: carbonic acid gas, the gas which gives the briskness to aerated waters, ammonia, and sulphurous acid easily, and oxygen and nitrogen with less ease. The quantity of gas that water can hold in solution depends upon the temperature and upon the pressure of the atmosphere. We all know, for example, that in hot weather aerated waters, &c., very readily burst the bottles in which they are confined, or blow out the corks. This is because, under the influence of the heat, the water has been compelled to give off the gas it held in solution at a lower temperature, and the pressure of liberated gas has become too great for the bottle. This is the reason for iced champagne. The placing of the champagne bottle among ice causes it to dissolve much of the gas free in the bottle, but imprisoned by the wired cork, and when the cold champagne is taken into the warm mouth, the gas is rapidly liberated, producing the sharp pleasant sensation. It is the presence of ordinary air dissolved in water and of carbonic acid, that gives to it its pleasant flavour. If the water be boiled the gas is driven off, and the water becomes, in consequence, mawkish and insipid. If suspicious water has been boiled for safety, the pleasant taste may be restored by shaking it up in a large vessel, and thus causing it to dissolve more air. These facts regarding the physical and some of the chemical characters of water have, perhaps, no very direct bearing on the subject of which this section treats, but they are of extreme interest, and not so widely known as they ought to be.

We must now consider some of the properties of water of more direct relationship to the point of view from which, in this section, we must regard it.

Constituents of Water.—Water, we have said, always contains some dissolved substances, picked up as it passes through the atmosphere or filters through the soil, on the quantity of which depends the estimate one forms of the value of the water for drinking and for other domestic purposes. These constituents are of two chief kinds, inorganic, derived, that is, from the lifeless world of matter, such as common salt, lime, &c. &c., and organic, derived from animal and vegetable matter.

The solid constituents of water vary within very wide limits. The following table shows the total saline material present per gallon in a variety of waters:—

	Grains per gallon.
Loch Katrine supplying Glasgow	2
Grasmere	2·92
Rydal	3·11
River Dee supplying Aberdeen	4
River Tay supplying Perth	5
Water supplied to Liverpool	5
Claremont water	5·7

	Grains per gallon.
Farnham in Surrey	7·25
Clyde	9·19
Rhone	9·112
Nile	10·9
Rhine	16·247
Seine	17·84
Thames supplying London	20
Spring water	40-60
Jordan	75
Sea water, Shores of Baltic	1100
,, German Ocean	2380
,, Open Atlantic	2450
,, Mediterranean	2870
,, Dead Sea	17,200

Of these dissolved solids, the commonest is carbonate of lime or chalk. Another compound of lime often present is gypsum, or sulphate of lime. It is these substances, along with salts of magnesia, the carbonate and sulphate, which occur also very commonly, though in much smaller proportion, that give to water what is called **hardness.** Chalk is not very soluble in pure water, but it is always more easily dissolved in water containing carbonic acid gas, which natural water always does. If by any means the carbonic acid be driven off, the water cannot contain the lime in solution to the same extent, and thus some of it is precipitated in a solid form. Boiling thus expels the gas, and it is carbonate of lime, thus precipitated, that forms the crust so common in boilers. If a great quantity of lime be present this water may become milky by the precipitation. Water flowing among hard granitic mountains contains a small quantity of such saline material, a small fraction of a grain per gallon, while in well water, particularly in chalky districts, the quantity may rise to over 20 grains per gallon. Thus, what is said to be the purest of waters is that of the Loka, in the north of Sweden, which flows over insoluble granite rocks, and contains only $\frac{1}{10}$th of a grain per gallon of solid matter. In Bala Lake, North Wales, there is less than $\frac{1}{4}$ grain of lime and magnesia salts per gallon. Loch Katrine water is exceedingly soft, containing only a little over $\frac{1}{2}$ grain of lime per gallon, and $\frac{1}{10}$th of magnesia per gallon. The waters of the various London Water Companies contain 8 or more grains of lime per gallon, and from $\frac{3}{10}$th to $\frac{8}{10}$th grain magnesia, and are, therefore, hard waters. Deep well waters are usually hard waters, containing a higher percentage of these ingredients than either river or lake water. In mine waters the quantity is still greater. Such waters are not well fitted for domestic purposes, cleansing operations being performed with difficulty. Nor are they as a rule agreeable to the taste, being somewhat harsh, though they are commonly bright and sparkling. The lime causes soap to curdle, and a lather cannot be formed till sufficient soap has been used to combine with the excess of lime, so as to render the water soft. Thus they are always extravagant in the consumption of soap. Of all ordinary waters, rain water contains least of such saline substances, therefore it is so soft, and desired in districts where the water, supplied for domestic purposes, is hard. The curdling of soap by hard water is made use of as a test of the degree of hardness. A solution of soap is used and added to a definite quantity of the water, till a lather be formed and remains for five minutes. The hardness is then expressed in degrees. Thus, water, which requires ·012 of a pound of best hard soap to 10 gallons before a lather will remain, is water of 1° of hardness.

How to soften hard water becomes, then, a question of some importance. One method, already explained, is by boiling the water. A second process is that of Dr. Clark, of Aberdeen. His process consists in the addition of quicklime to the hard water, 1 ounce of quicklime to 1000 gallons of water for each degree of hardness. This may seem a strange way of getting rid of the hardness, by adding more of the very agent which one desires to get rid of. The explanation is that the quicklime forms with the carbonic acid a fresh supply of carbonate of lime. The carbonic acid being thus removed, this carbonate of lime is precipitated, and with it the carbonate of lime originally present, and kept in solution by the free carbonic acid gas. The carbonates are allowed to subside and the water run off. This method is employed by manufacturers using enormous quantities of water, but it is not possible for householders. If the hardness is caused by sulphates of lime or magnesia, boiling, &c., will not remove it. The addition of common washing soda, till the water seems to appear milky, will, in this case, soften it, because the sulphates are converted into carbonates by the soda, and are precipitated. Water so softened must not, of course, be used for drinking or cooking purposes.

There is an idea that very soft waters, such as that of Loch Katrine in Scotland, are not so wholesome, because of the absence of lime salts, as others which contain them in more abundance. The latter have been supposed to be more useful, in the case of children, for example, for the growth of bone and so on. There does not seem to be any substantial ground for such an idea. When one considers the quantity of water drunk per day, one can see that a very insignificant amount of lime could be introduced into the body in this way, and lime salts are better supplied in the ordinary way of food. The addition of lime water to milk or drinking water, for such purposes is, the author believes, a serious mistake, as the lime is apt to be precipitated in the bowels, and to interfere in other ways with the due process of digestion.

Common salt, or chloride of sodium, also is found, as a rule, in ordinary water, though in very small quantities, 1 or 2 grains per gallon. It is the presence of this small quantity, however, that causes the milkiness to appear, if a drop or two of solution of nitrate of silver (lunar caustic) be added to the water, the cause of the milkiness, for example, in the washing of photographic prints. A large quantity of this substance in water, unless it had been from near the sea-shore or from a well in the neighbourhood of deposits of salts, would make one suspicious of admixture of sewage, which invariably contains common salt in solution. Sea water is, of course, rich in common salt, containing over 2000 grains per gallon. The Dead Sea contains nearly 8500, while from Elton Lake, in Russia, two hundred thousand tons of salt are annually obtained.

Salts of potassium are also found in ordinary water in minute quantity, and traces of iron. Mineral waters contain various metals, but these will be mentioned in the paragraphs devoted to such waters.

Besides these substances, which are wholly derived (the exception about common salt having been noted) from the inorganic world, there are other solid substances of a saline nature, derived directly or indirectly from organic bodies, and demanding very special heed. These substances are nitrates and nitrites, compounds of nitrogen with sodium, potassium, or calcium, as nitrate of soda, nitrate of potash, or nitrate of lime. The nitrogen of these compounds is derived from animal or vegetable substances. The presence of such salts in the water indicates, that at one time or other, animal or vegetable matter gained entrance to the water, it may have been in the form of sewage, and that, by a process of decomposition, the organic matter has been broken down and resolved into inorganic substances. This process is performed by the agency of the oxygen dissolved in the water and derived from the atmosphere. The organic substance, in fact, undergoes a species of oxidation, of burning, by which its organic form is destroyed. Now, the presence of nitrates or nitrites is not in itself injurious. They are harmless, provided they do not exist in excessive quantities. The presence, however, of the decaying animal and vegetable matter itself would be injurious, and, but for the process of oxidation, water to which it had gained access would always be threatening to health. The presence of nitrates and nitrites, therefore, is indication of previous contamination of the water, though it does not necessarily imply unwholesomeness of the water. In wholesome water no more than traces of these substances should be present, not more than 0·35 grains in 100,000, according to Hassall.

Gases dissolved in Water.—Gases are present in water in solution. The chief gases are oxygen and nitrogen, obtained from the atmosphere, but oxygen in greater proportion than is found in the air, because water dissolves it more readily than nitrogen. "Twenty-five gallons of water will contain about five pints of these gases," consisting of rather less than two of oxygen and rather more than three of nitrogen (Attfield). Carbonic acid gas is present, usually in considerable quantity; thus twenty-five gallons of water may contain one or even two gallons of dissolved carbonic acid gas, according to circumstances, for carbonic acid gas is very readily soluble in water. Carbonic acid gas is also a product of the oxidation of organic matters present in the water. Just as the nitrogen unites with oxygen and bases, such as sodium, to form nitrites or nitrates, so the carbon of the organized body unites with the oxygen in the water, the atmosphere being an ever-present store whence the water may derive fresh supplies. If carbonic acid gas is an indication of organic material having been present in the water, it is also an indication that nature's purifying process of combustion has been going on, and that the possibly hurtful organized body has been reduced to harmless simplicity. The presence of these dissolved gases gives to water a pleasant sharpness. Without them water would be tasteless and insipid, as water always is which has been boiled, because the heat has expelled the dissolved gases.

Impurities in Water.—Organic.—The chief impurity in water is organic matter, which may be present in the water in suspension merely, or in solution. This organic matter may be derived merely from dead and decaying vegetable structures, washed into the water of a stream, for example, by the rain, or from dead animal matter also, undergoing gradual decay in the fields and ditches, or in the stream itself, or it may be derived from human excreta and the refuse of human habitations, owing to the opening of sewers into the stream, or owing to the trickling of the liquid from a dungheap, for example, finding its way into a well. Of all sources of pollution, the last is the most serious. Now, the nature of the impurities thus cast into water will be readily understood. To take one illustration, urine contains in solution (see p. 292) chiefly urea, a nitrogenous body, the product of the oxidation of albuminous food-stuffs in the body, uric acid, also a nitrogenous body, common salt, phosphates of soda, and other compounds of phosphoric acid, sulphates, &c. Now, if sewage is gaining access to a water supply to any extent, common salt, phosphates, and sulphates, will be found in the water in greater quantity than is usual in ordinary water, derived from the urine, and the unusual quantity of these inorganic, and in themselves harmless, constituents would raise suspicions in an analyst's mind as to the purity of the water. Further, he will be able to detect the presence of a substance containing nitrogen, derived from the urea and uric acid. If he can determine in what form the nitrogen is present, he will obtain a good idea of its source. Everyone knows that if urine stands for a time, it decomposes, becomes muddy, and gives off an offensive ammoniacal smell. This is because, under the influence of atmospheric organisms, the urea becomes converted into carbonate of ammonia. All the urea might thus become transformed, and be no longer found as such; but the fact that an organic body had been present would be signified by the detection of the ammonia, which is formed of the nitrogen formerly existing as urea, and originally derived from albuminous food. With the lapse of more time, further changes would occur, still further altering the form in which the nitrogen existed; these changes being due, as already noted, to oxidation process, the tendency of all the change being to break down hurtful organic bodies into harmless and simple inorganic substances. Albuminous substances themselves gain access to water, and may be detected by the chemist as such, but they undergo in course of time the same transforming process by the agency of the dissolved oxygen of the water. Thus in searching for impurities in water, the chemist tests for albuminoid substances themselves. If they exist beyond the barest trace, that implies that the water is contaminated with material which nature has not yet had time to reduce to simple and harmless forms. Such water is not fitted for domestic purposes, unless purified by some means, and stands, therefore, condemned. Should, however, his tests fail to find such organized material he tests for ammonia, for nitrites, for nitrates, in short, for the substances which would result from the presence of organic impurity, if there had been time for oxidation to occur. If these are found, in any amount, the fact that at some part of its course the stream is contaminated is established, although before it reached the place where the water was taken for analysis nature had had time to effect her purifying processes.

Now, the mere presence of albuminoid material or of its oxidized products does not necessarily render water impure. There is no manner of doubt that such polluted water is continually being used for domestic and drinking purposes, and without harm often resulting. It is not even the quantity of such impurity that determines the unwholesomeness of the water, for one well may be largely contaminated with sewage, and may be consumed without doing any perceptible injury; another, in its neighbourhood, may be so slightly contaminated, that the detection of any impurity in it is a matter of difficulty, and yet it may bring disaster to every household using it. It is the exact nature of the organic pollution that makes the difference, a difference which may be absolutely undetectible by the most delicate tests, and yet may be appalling in its results. Take an illustration: a farm possesses a well, in the immediate neighbourhood of which the dungheap is foolishly permitted to lie. All the waste water and excreta from the farmhouse, all the manure from the stables and byre, &c., are thrown on this heap. The watery portions from the heap filter through the ground and gain access to the well. The water of the well is used by the people of the farm for their own domestic purposes, for washing milk-cans, and so on. This state of things may last for years and no one be apparently any the worse of the polluted state of the well. But one of the farm hands takes typhoid fever and is nursed at the farm. The excreta from the patient are also thrown on the heap, and filter into the well. The pollution of the well is not altered in *quantity*, it is no more than it has been for years, but it is altered in *character*. A peculiar character has been imparted to it, marked by an outbreak of typhoid fever among those to whom the milk from the farm is distributed, because the milk has become in turn polluted by the water, used to wash the milk vessels or to mix with the milk. No chemist could detect by any test whatever the poisonous character that had been imparted to the well. He could determine that it contained organic impurity, but he could do no less, perhaps only a brief month before, when the water was apparently harmless. Perhaps if things are simply allowed to go on, as they often are, the patient dies or recovers, no more typhoid excreta are thrown upon the heap, though the excreta of the dwelling are consigned to it as before, water still filters into the well as before, and pollutes it as much (in quantity) as before, but its death-dealing power disappears and it becomes again harmless. Still to chemical analysis it yields no indication of difference. When it is impossible to distinguish between an organic impurity which is harmless, and one which is harmful, there is only one means of obtaining safety, and that is to declare as unfit for use any water which contains organic impurity to any appreciable extent, and entirely to condemn any water in which even a slight trace of organic impurity appears to be due to sewage pollution.

Gaseous Impurities in Water.—Ammonia, being derived from organic bodies, has been already referred to as an impurity. Sulphuretted hydrogen is also derived from the oxidation of organic substances. Sulphurous acid gas and various other vapours may be derived from the atmosphere, and are frequently found in rain water. Their presence depends on the kind of chemical works, manufactories, &c., in the neighbourhood. Carburetted hydrogen is another gaseous impurity sometimes found.

Metallic Impurities in Water.—Water is sometimes contaminated with lead, zinc, copper, iron, and arsenic. These are generally derived from cisterns or pipes for either storage or distribution of water. Rain water may contain zinc or lead from zinc lining the roof from which the water was collected. Arsenic may be derived from the atmosphere. The common contamination, however, is from lead. The purest water, that which contains least saline ingredients, and is consequently very soft water, is that which most readily acts on the lead piping. Water which contains organic matter, nitrite of ammonia, and chlorides, also readily becomes impregnated with lead. On the other hand, waters rich in carbonic acid gas and hard waters themselves afford the best protection, for the carbonic acid forms with the lead an insoluble carbonate, and this coating the metallic surface prevents further action on the metal. In the same way carbonates, phosphates, and other salts form a coating. It appears, however, that an excess of carbonic acid will redissolve some of the carbonate of lead, and thus waters, aerated waters, for example, highly charged with carbonic acid, are open to metallic contamination. Acids derived from organic substances, such as fruits, vegetables, beer, &c., act strongly upon lead, and water containing such impurity readily acquires also metallic contamination. The result of drinking water containing lead to any amount is symptoms of lead-poisoning, of which one of the earlier is lead colic, and one of the later is lead paralysis. Cases of lead-poisoning have arisen, according to Dr. Angus Smith, from as little as $\frac{1}{100}$th grain per gallon; but some persons are more susceptible to the action than others. According to Parkes any quantity over $\frac{1}{20}$th grain per gallon should be considered dangerous. It may be noted that water in cisterns may acquire lead from a leaden cover, with which the water does not make contact. Vapour of water spontaneously rising from the cistern condenses upon the lid. It is thus distilled water, acting most readily upon the lead, of which it dissolves some portion, and the drops falling back into the cistern carry lead in solution with them. The cistern should, therefore, be provided with a wooden or slate cover.

The Various Kinds of Water differ in the quantity and kinds of their constituents.

Distilled Water is comparatively pure. It is entirely free of mineral constituents such as chlorides, carbonates, sulphates, &c. It is prepared by placing the water in a vessel or boiler, fitted with a tight lid, from the centre of which a metal tube arises. The tube is prolonged and coiled to economize space. The heat applied to the boiler raises the water in vapour, which as it passes through the tube, or still, as it is called, condenses to steam, and then to water, which issues in drops and is caught in a receiver. To quicken the process the tube is surrounded by a tub through which cold water flows, thus quickly condensing the steam. From the water in the boiler the gases quickly pass off and may be allowed to escape before the water is collected in the receiver. If, however, the water employed contains ammonia in solution, or as carbonate or nitrite, it will be given off and be readily dissolved again by the condensed steam; so that unless proper precautions are taken, the distilled water may not be free of ammonia.

The water may also contain other impurities, readily given off as vapour to contaminate the distilled water. It is necessary, therefore, to employ water as free from organic impurity as possible. The first portion of the distillate ought always to be thrown away in any case. Further, the process should not be carried on till all the water in the boiler is driven off, lest some of the residue be blown over into the condenser. Distilled water is largely produced from sea water in sea-going vessels, thus getting rid of the difficulty of storage, and of the risk of the stored water undergoing changes and suffering harm from the tanks in which it is kept.

Distilled water is not at all palatable, owing to the absence of dissolved gas. This is overcome by re-aerating the water, mixing it again with air, for which purpose special apparatus has been devised, one in common use being that of Dr. Normandy.

Distilled water, containing as it does no solids, is peculiarly apt to dissolve minute quantities of the material of the pipes through which it passes. Lead pipes are particularly liable to attack, and lead-poisoning has frequently been produced in this way, not only from pipes themselves, but from the joints of the distilling apparatus. The boiler should be of earthenware, iron, or copper, the pipes of earthenware or tin, and the condenser of the same, copper pipes and condensers being avoided. Zinc pipes should also be avoided.

Rain Water, if proper arrangements exist for its collection and storage, ought to be a very pure and soft kind of water. It never can be absolutely pure, for in its descent through the atmosphere it will dissolve gases of the atmosphere, as well as solid matters floating in the air, and it will also wash down with it floating matter which it may yet be unable to dissolve. What the nature of the dissolved and suspended matter is will depend, accordingly, upon the nature of the atmosphere through which it falls, and the constituents of the rain water will afford an indirect method of determining the nature of the atmosphere. In country places, devoid of manufactories or large collections of houses, it will be purest; and in manufacturing districts and in large towns it contains considerable impurity, both of an inorganic and organic kind. Nitrogen and oxygen gases it will contain in solution, and also carbonic acid gas, but in very small proportion compared with well waters, for the atmosphere contains only 4 parts of this gas in 10,000. Sulphurous acid, hydrochloric acid, nitric acid, ammonia (free and in combination), &c., will also be in the atmosphere, derived from chemical and other works. Organic impurity, swept down from the air, is also present in larger or smaller quantity, derived from animal emanations. Thus Dr. Angus Smith states the amount of free ammonia and albuminoid ammonia found in the rain water of various localities, of which a few samples are given:—

In rain obtained at Valentia, Ireland,	there were	0·180	parts of ammonia per 1,000,000.
,, ,, at west coast of Scotland	,,	0·484	,, ,, ,,
,, ,, ,, ,, England	,,	1·900	,, ,, ,,
,, ,, in London	,,	3·450	,, ,, ,,
,, ,, ,, Manchester	,,	6·469	,, ,, ,,
,, ,, ,, Glasgow	,,	9·100	,, ,, ,,

The albuminoid ammonia in rain water varied from 0·034 parts per 1,000,000 in Valentia to 0·105 on the west coast of Scotland, 0·251 in Manchester, and 0·3 in Glasgow. Of inorganic constituents sulphates amounted to 0·1911 grains per gallon rain water at Valentia, 2·9 in Manchester, and 4·9 in Glasgow. The contrast between the state of the atmosphere in Valentia and in Glasgow is very strikingly shown in such figures as these. Near the sea, salt is acquired from the atmosphere. In the country, 2 grains per gallon is about the average quantity of all the constituents of rain water. To this, however, must be added varying quantities dependent upon the mode of collection. If it has come into contact with limestone walls, roofs, &c., chalky substances will have been acquired; if with tile roofs, vegetable matter is likely to be present, because of the low forms of vegetable life usually found on such roofs; if it has been collected on a zinc-lined roof, lead contamination may be present. Slate roofs are least apt to yield any notable addition to its constituents. Further, care must be taken with the pipes through which it passes, as its freedom from constituents makes it readily attack lead, and with the cisterns in which it is stored —slate cisterns being the best, or cisterns made of brickwork, set in cement and plastered over with it. The gutters along which the water flows to the tank should be cleaned at regular intervals. It is advisable not to allow the first portion collected after dry weather to be run into the cistern; and for drinking purposes it should be filtered, through three or four feet of clean gravel, and then through one or two feet of charcoal. This not only removes impurities, but also aerates the water. Rain water is highly desirable for domestic purposes because of its softness, and is, when the precautions indicated have been followed, less likely to be contaminated than other kinds, and most wholesome and palatable.

Ice Water is comparatively pure. In the process of freezing the gaseous and saline ingredients are separated out, so that ice formed of salt water is yet free of the salt and very pure. Water obtained from melted ice is flat and insipid because of the absence of gas.

Snow Water is for a similar reason very pure. There is a popular opinion that water obtained from melted snow is unwholesome. There is no ground for this view, for when melted it is as good for quenching thirst and as wholesome as other kinds of water, though the absence of gas renders it less palatable.

Well Water is rain water which has passed into the soil, and filtered its way through it till it reaches the level at which the ground is saturated. The soil acts as a sponge, absorbing and retaining within its interstices water, more or less according to the nature of the soil. In its course the water dissolves much of the earthy constituents it meets with, and the exact nature of its mineral constituents will consequently depend on the strata through which it passes. Usually well waters are hard waters, because their prolonged passage through the soil has permitted them to dissolve much calcareous and other material they have come into contact with. Thus 15 to 25 grains per gallon is a common amount of solid matter for deep wells in the chalk, which yield as a rule wholesome and pleasant water. Now, in its course through the soil the water will carry with it much organic material, from decaying vegetable or animal matter on the surface, perhaps from manure spread over the surface, and so on. If the water percolates far enough through the soil this organic matter is all destroyed, oxidized, burnt, in its passage. It undergoes chemical union with the oxygen contained in the ground air, in the pores of the soil, and ceases to be organic substance as such. The products of this combustion, in the form of nitrates, are in the water, but are harmless. If this be understood, it explains at once the difference between the water of shallow and of deep wells. The former collect water which has passed through only a few feet of soil, sufficient perhaps to deprive it of all muddy appearance, so that it looks clear enough, but not sufficient for the oxidation changes to be completed. Surface wells are always to be regarded with suspicion, especially if in the neighbourhood of habitations, whether for man or beast, as it is almost certain some of the surface drainage will gain access to it. Deep wells may be polluted in the same way, the water which rises up in the depths of the well being perfectly pure, but the manner of building the well permitting surface water to soak into it from above. For the purpose of preventing this, if the well is built of brick a good facing of cement is most useful. If the well has been polluted, it is difficult to get rid of the contamination, even after all further access of impurity has been prevented. A considerable time must be allowed to elapse, and the natural process of purification may be aided by removing as much of the water as possible on several occasions. Deep well waters are usually sparkling and pleasant to taste from the abundance of carbonic acid they contain. This carbonic acid is produced as the water finds its way through the soil, because the carbon of the organic material, undergoing oxidation, unites with the oxygen of the air in the soil, and carbonic acid gas is formed. Deep well water is usually brought to the surface by pumping; and pump water and deep well water signify commonly the same thing.

Spring Water is the same in its nature as ordinary deep well water. The fact that the water *springs* is due entirely to mechanical conditions. The water issuing from a spring at the surface, whether the surface be a natural one or one artificially produced, as, for example, in digging a well when a spring is come upon, has its gathering ground at a higher level than its point of issue. But it has been prevented sooner reaching the surface by impervious strata of earth; and when at last it is able to flow up to the surface, it comes with a rush more or less marked according to the difference of level between its point of outflow and its gathering ground. If, at the point where it flows out, one were to build a wall round it, it would rise in the cylinder thus formed, until it reached a height equal to that of its gathering ground, wherever and at whatever distance that might be. One would then have a well, only above instead of below the surface level. If, through long-continued drought, the level of water in the gathering ground fell, the height of the column of water in the tower would fall also; and if, by long-continued rains, the level of the former rose, that of the latter would rise also.

This is the explanation of intermittent springs. The level of water in their gathering ground is not always so high as to keep a continual outflow at the spring. It is only after heavy rains at the high ground that the spring flows out, and when, after the rains have ceased, the level of the ground water at the high land falls, the overflow at the spring ceases.

Artesian Wells (Fig. 258) are bores passing often great distances into the ground, through impervious strata, and tapping streams, flowing through the lower pervious layers, whose gathering grounds are much higher than the surface of the bore. When the stream is thus tapped the water rises in the bore and overflows on the surface because of the difference in level. This is represented in the figure, where D taps water in the pervious stratum C C kept from reaching the surface A by the impervious stratum B B.

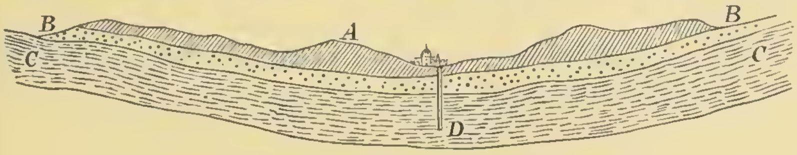

Fig. 258.—Artesian Well.

One of the earliest of such wells was in the French village of Artois, hence the term Artesian. The well at Grenelle, Paris, is 1800 feet deep, and contains a large quantity of carbonates of sodium and potassium.

River Water is rain water collected from the uplands, with additions perhaps from springs, and, as it flows through the lowlands, with additions of surface water from fields, waste and sewage from farms, villages, &c., on its banks. Its quality will be very different near its source from what it is near the sea. In the high lands it will contain ingredients washed down into it from the hillside, and gained as it passes through glens and ravines. But such water is likely to be extremely wholesome and pleasant. Any organic substance in it is not likely to be productive of harm, being derived from natural sources; and, besides, in the course of the water downwards, the combustion of the organic material occurs; and as it is broken up into spray and mixed with air in tumbling over cascades and dashing into foam in its irregular broken channel, it is undergoing a rapid process of purification. But, as the river flows through cultivated and highly-manured fields, and receives a large quantity of impurity from farms, &c., it becomes difficult for its purity to be maintained. The water is not so freely exposed to and mixed with the air, and its organic impurity is not so readily burnt off. If manufactories crowd its banks, and sewage from towns is cast into it in quantity, purification by natural means becomes almost impossible. River water, therefore, unless when taken high up the stream, is almost invariably contaminated, and forms an exceedingly unsafe source of supply.

Lake Water varies in composition according to the district over which the rain water and streams formed by it flow. When the lake is in an upland, surrounded by hills, from whose streams it is supplied, and when the hills are of hard formation, with little limestone, and when the lake has full and easy outlet by streams, the water is of a very pure and wholesome character. For the mountain streams in their descent dissolve little material, and the free outlet prevents the accumulation of solid material in the water. A lake like the Dead Sea, with little outlet but by evaporation, becomes highly charged with saline ingredients, for the evaporation continually causes concentration. Mountain lakes with free outlet form the most valuable sources of water supply, provided they are free of impurity from human habitations. A good illustration is Loch Katrine in Scotland, supplying Glasgow, which contains only 2 grains of solids per gallon; Thirlmere in Cumberland and Bala in Wales contain about the same amount. The total solids yielded by five gallons of Loch Katrine water might be heaped on a threepenny piece. Waters derived from peaty districts are often discoloured and flavoured by suspended matter derived from the peat, which is not, however, hurtful, and is easily separated by filtration. Such waters are often less pleasant, because of the smaller quantity of dissolved gases they contain; but these can be imparted to them by filtration through gravel and charcoal beds, which also improves them by permitting the process of combustion to occur, and thus removing traces of organic matter. In course of transit through iron pipes such waters undergo an improvement.

These various kinds of waters have been classified, as regards quality, by the Rivers Pollution Commissioners as follows:—

Wholesome	1. Spring water.	Very palatable.
	2. Deep well water.	
	3. Upland surface water.	Moderately palatable.
Suspicious....	4. Stored rain water.	
	5. Surface water from cultivated lands.	Palatable.
Dangerous...	6. River water to which sewage gains access.	
	7. Shallow well water, to which sewage gains access..................	

Sea Water is rich in salts, specially chloride of sodium, common salt. Of this salt the water of the British Channel contains over 2000 grains per gallon; magnesium salts are also present in considerable quantity, and salts of lime. Sea water contains also bromine and minute quantities of iodine and fluorine. The richness in salts is supposed to be due to the continued inflow from rivers, &c., of waters containing them in solution, which is never returned from the sea, as it loses only water by evaporation. Organic matters from vegetable and animal life present within it and derived from tributaries also, of course, abound, and gases are also present in solution. The composition of sea water varies in different places, according to the character of contributions made to it by rivers, and for other causes.

The Detection of Impurities in Water.—The determination of the nature and quantity of the various constituents of water is the business of the expert chemist, and the examination of one sample just sufficiently to enable him to say whether it is wholesome or not will occupy many hours, while its exact analysis will occupy days. In taking water for the purpose of sending it for analysis, persons should be careful to take a fair sample. The bottle used should be thoroughly cleansed, and after it is quite clean it should be rinsed out several times with the water that is to be collected. Care should be taken that the stopper is also quite clean. In the case of service pipes, the water should be taken if possible direct from the main. River water should be taken well in the stream, the bottle being plunged overhead. The best bottles are what druggists call Winchester quarts, of which two had better be sent, filled up to the neck, though one such quart would be sufficient for a partial analysis. The source of the water—well, river, lake, &c.—should be stated, as well as any circumstance as to situation of well, depth, surroundings, that may seem to have a bearing on its purity.

While a careful analysis is a very laborious proceeding, involving much knowledge and practical skill, it is yet possible for anyone to make a few rough tests with water that will suffice, for the time being, to indicate whether the water is subject to any marked impurity. For example, any householder might roughly satisfy himself as to the character of the water taken from a well attached to a country house where he wishes his family to holiday; and so on. The chief points to be noted are stated in the following paragraphs:—

Colour of the Water.—The water is taken in a long glass cylinder, standing on a white porcelain plate, and the plate looked at through the column of water. The colour of pure water is a greenish-blue, but it requires a mass of it, perhaps a depth of something like 10 feet, to show it clearly. But the column of water in a tube two feet long even will reveal any suspended matters giving other colour to the water. Mere traces of peaty matter and other material in suspension will be revealed in the brown appearance the porcelain plate will have when viewed through the column.

Odour of the Water.—Pure water has no perceptible odour. If any smell is detected the water is to be regarded with suspicion. A simple method of testing consists in filling an ordinary water-bottle to within a third of the top, with the water, closely covering the top with the palm of the clean hand, vigorously shaking the water, and then sniffing up with the nose thrust well into the mouth of the bottle, the hand not being removed till one is ready to insert the nose at once. If a bad smell is perceived, the water is impure. If no bad smell is perceived, the water is not necessarily pure. A more searching test consists in warming the water in a stoppered flask up to 100° Fahr., shaking it, and then suddenly removing the stopper and smelling it. Decaying animal and vegetable matter will be indicated by a bad odour. The same test may be applied, though not so quickly, by corking up some of the water in a clean bottle and setting it aside in a warm place for a day or two, then shaking the water and smelling it.

Flavour of the Water.—Not much can be learned from this. The purest water is the most insipid, from the absence of gases, and the best flavoured water may contain considerable organic impurity. Excess of salts will be readily detected; thus in the case of wells near the sea, the entrance of sea water gives a brackish taste.

To detect organic impurity in the water, there are two tests that may be employed with perfect ease. One is Nessler's test, the other is the test with permanganate of potash. The former detects ammonia in the water, and ammonia, as we have seen, is one of the products of the burning in the water of organic substances, so that the detection of ammonia by Nessler's test indicates that organic matter has previously gained access to the water, though it has had time to undergo change. The latter test is used to indicate whether there yet exist in the water organic substances not yet oxidized, still in a state of change, for this would be a much more serious impurity than the former. In analysts' reports these two kinds of impurity are signified by the terms "free ammonia" and "albuminoid ammonia." The analyst determines first the quantity of ammonia existing as such in the water. He then wishes to know how much organic matter as such is present. To determine this directly is not an easy matter, and so he falls upon the expedient of chemically acting upon any organic matter the water may contain, so as to produce ammonia from it, and then he finds it easy to determine the quantity of ammonia so produced, and hence to calculate the quantity of organic substance that must have been present to yield it. Hence the use of the phrase "albuminoid ammonia."

Nessler's Test is ordered to be prepared as follows:—35 parts of iodide of potassium are dissolved in a small quantity of *distilled water;* a saturated solution of bichloride of mercury is now added, little by little; a red precipitate appears, which is almost immediately dissolved. In continuing to add, a point is at last reached when the precipitate commences to be insoluble. Sufficient bichloride solution has then been added, and the liquid is filtered. To the filtrate 120 parts of caustic soda (or 160 parts caustic potash), dissolved in water to a strong solution, are added. The total quantity of liquid is then made up to 1000 parts. Finally 5 parts of a saturated solution bichloride of mercury are added, to clear up the solution and make it sensitive. On standing a deposit appears, from which the clear liquid should be decanted into a large stock bottle, well corked. For use a small bottle should be used, filled from the larger as required to prevent frequent opening of the stock bottle, which would render it cloudy.

Now place some of the water to be tested in a clean glass, and add a very small quantity, a drop or two of the Nessler solution. Allow it to stand, covered, in a good light. The appearance of a yellow colour indicates the presence of a small quantity of ammonia. If a dark yellow be produced, still more a brownish colour, and still more if a yellow precipitate forms, the presence of ammonia in quantity is indicated. Nessler's test is said to indicate by the colour the presence of ammonia, should even so small a quantity as only 1 part of ammonia be present in 20,000,000 parts of water. And as the ammonia can readily be concentrated by distillation, the presence of only 1 part in 200,000,000 parts of water is said to be detectible by Nessler's test.

The Permanganate Test is applied by taking the water to be tested in a glass vessel, and adding about a tea-spoonful of weak sulphuric acid, then dropping in a few drops of a weak solution of permanganate of potash, and stirring with a glass rod. The permanganate is to be added till a rich rose-colour is acquired by the water. The vessel is then covered with a clean glass plate and allowed to stand in a good light. If there is any quantity of organic matter present the colour will go in a few minutes. A few more drops of the permanganate may be added, and the time that elapses before the colour is again destroyed noted. For the purpose of comparison a similar vessel containing distilled water may be set alongside the water to be tested, and coloured with the solution, and this may be used as a standard, as it should retain its colour, by which to judge of any change in the colour of the water being tested. The permanganate solution is robbed of its colour because it readily yields up the oxygen it contains to any body capable of becoming oxidized by it. Thus the organic matter seizes upon the oxygen, undergoes combustion, and becomes destroyed in the process. The quantity of the solution of permanganate requiring to be added time after time before the rose-colour is permanently obtained may, therefore, be made a measure of the quantity of organic material present in the water: the more organic matter, the more oxygen needed for combustion, and, therefore, the more permanganate decolorized. The results of the permanganate test require, however, to be taken with some reservation. Nitrous acid, commonly present in water, will also destroy the colour. Now nitrous acid indicates previous contamination of the water, that is organic impurity which, however, has undergone already partial destruction, and is not so serious a constituent as actual organic matter. Iron also destroys the colour. Good drinking water, such as Loch Katrine, will, however, have no perceptible effect on the colour till after the lapse of 24 or more hours, showing merely traces of organic material. Thus an ordinary analysis of Loch Katrine water shows of free ammonia 0·004 parts in 1,000,000, and of albuminoid ammonia 0·08 parts per 1,000,000.

If two tests mentioned, when applied to a particular sample of water, indicate organic impurity, a rough confirmatory test may be sought by applying the test for chlorides; for if sewage is gaining access to water, the quantity of chlorides is certain to be increased because of the quantity of chloride of sodium, common salt, in urine. The test is a drop of nitric acid and then a few drops of a weak solution of nitrate of silver (2 grains to the ounce are sufficient). This with good water will give a faint cloudiness, for a small quantity of chlorides is always present; but if there is a marked white precipitate produced, the evidence of sewage pollution is almost conclusive, always under the condition that the water has not been taken from near the sea-shore, where salt water could gain access to it.

The Detection of Lead in Water.—To the suspected water add a few drops of nitric acid, mix with a glass rod, then add a drop or two of sulphuretted hydrogen water. A very faint trace of lead will be revealed by a brown discoloration of the water. The delicacy of this test is exceedingly great. It will indicate the presence of 1 part of lead in 100,000,000 of water.

The Microscopic Examination of Water often reveals the presence of vegetable and animal matter, dead and living. By this means one will often be able to detect undoubted evidence of sewage contamination, owing to the presence of undigested remains of food, derived from excreta, fragments of vegetable tissue, starch grains, fragments of muscular fibre, and so on. Besides these, living forms are found in river water, water from ponds and marshes, surface water in general, and sometimes in the water of shallow wells. They are readily found in water contaminated by sewage, and they never occur in water of deep wells and springs, that are not polluted. Their presence is sure evidence of a dangerous pollution. These living forms belong to a great variety of species, desmids, diatoms, confervæ, infusoria of many kinds, animal forms of the worm family, and bacteria or germ forms. A drop of water from any stagnant pool abounding in decaying vegetable matter will show such things in multitudes. The presence of such living things in water—of all of them, or of any one kind of them—does not imply any special unwholesome character. It indicates that the water is impure, is being contaminated in various ways, and that opens up a vista of endless possibilities. The figure (Fig. 259) is one modified from Hill Hassall, who was the first to direct attention to the importance of the microscope in the examination of water.

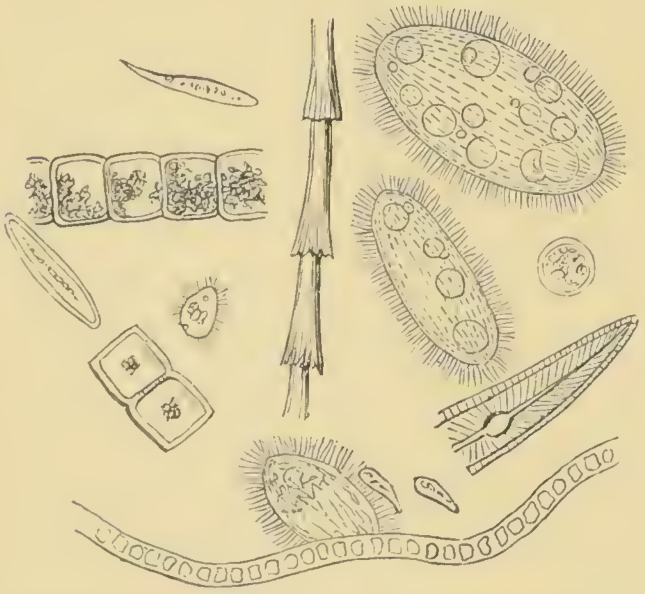

Fig. 259.—Some Animal and Vegetable Structures found in a Drop of Thames Water.

The Purification of Water.—Filtration.—The chief means of purifying water is by filtration. Now filtration acts in two ways. It acts obviously as a mechanical obstacle to the passage of matter contained in the water not in solution but in suspension. Consequently, water impure simply from the presence of earthy particles, peaty substances, and so on, which give a brownish tint to the water, is rendered quite clear by passing through the filter. But filters, specially the filters of gravel, sand, charcoal, and spongy iron, and the like, used for water filtration, act also chemically. As the water slowly finds its way through the pores of the filter, which are occupied by air, it meets with oxygen and the process of combustion goes on, so that the water that has passed through is purified, not merely because suspended matters have been removed, but also because some organic impurity has been consumed. Further, the water becomes aerated in its course through the filter, by taking up not only air, but carbonic acid produced in the oxidation process. Water companies filter the water they supply in large paved tanks provided with perforated tubular drains, which are covered by several feet of gravel, coarse at the bottom and becoming fine at the top, while over the gravel is a layer of sand several feet deep. The water is slowly and regularly admitted to the tank, the depth of water being never very great, in order that the water may not be forced through. For filtering purposes, however, nothing is equal to pure well-packed animal charcoal, which removes organic impurity much more thoroughly than other materials. The silicated carbon filter, magnetic carbide of iron filters, and filters of spongy iron are also very reliable. Slow filtration through a layer of animal charcoal, in coarse powder, 4 inches thick, will, according to Wanklyn, purify river water containing a considerable quantity of organic impurity. After being used some time the charcoal needs renewal or cleaning. It may be cleaned by washing it first with a solution of permanganate of potash (10 to 15 grains to the pint of distilled water, with a few drops strong sulphuric acid), then in dilute hydrochloric acid (60 drops to the gallon of water), and then in pure water, afterwards drying it. Merely exposing the charcoal to the open air for some hours will destroy the organic impurity it has retained, or exposing it to a considerable heat.

Filters for Domestic Use.—Two kinds of filters are shown in Figs. 260 and 261. The latter consists of a block of carbon through which the water requires to pass to get from the upper to the lower vessel. The former is a specimen of one kind of filter, of which there are now many in the market, which are easily cleaned. The large earthenware jar contains within it a smaller one containing the filtering apparatus. The latter is formed of a block of carbon (bl), and above it a layer of granulated charcoal (ch), kept in position by a porous earthenware plate (p). All these parts can be removed for renewal or cleansing. The water is poured into the upper part of the inner jar and passes through the filtering beds to the space below.

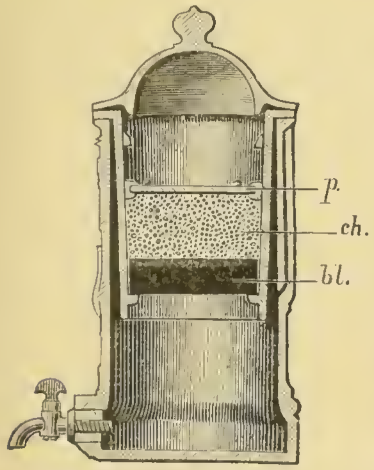

Fig. 260.—Cleansible Filter.

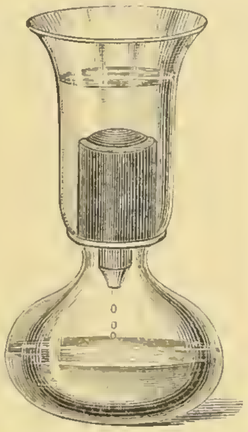

Fig. 261.—Glass Table-filter.

Domestic filters require attention to secure constant cleanliness. It is to be feared that many filters are used year after year, without ever being cleaned. Under such circumstances they are more likely to render the water that passes through them impure than to purify them. Even when the organic impurity in the filtering water is small, the filter should be cleaned or renewed every few months, and oftener if the water contains much contamination. Many filters require returning to the makers for cleaning, others may be renewed and cleaned by any one with ease. Parkes gives the following directions for the cleaning of filters to avoid taking them to pieces:—Every two or three months (according to the kind of water) air should be blown through, and if the charcoal be in the block form it should be brushed. Then 4 to 6 ounces of the pharmacopœial solution of potassium permanganate, or 20 to 30 grains of the solid permanganate in a quart of distilled water, and 10 drops of strong sulphuric acid should be poured through, and, subsequently, a quarter to half an ounce of pure hydrochloric acid in 2 or 4 gallons of distilled water. Three gallons of distilled or good rain water should then be poured through, and the filter is fit again for use. If the filter can be taken to pieces the charcoal can be spread out in a thin layer, and exposed for some time to the air and sun, or strongly heated in an oven.

A simple filter for domestic use may easily be made with a flower-pot. The lower part is filled with coarse pebbles, over which is placed a layer of fine pebbles, and above that a layer of clean coarse sand. On the top of this, place a piece of burnt clay perforated with small holes, and cover it with a layer, 3 or 4 inches thick, of well-burnt pounded animal charcoal.

Clarification of Water by Alum, Oak Chips, &c.—When it is suspected that a considerable quantity of organic impurity is present it is well to boil the water before it is filtered. It may afterwards be mixed with air by agitation. Another method of purifying water consists in adding to it something which will clarify it, as white of egg is added to jelly for the same purpose. Alum has specially been used for this purpose, of which 6 grains is added to each gallon of water. The action is most effective when the water contains carbonate of lime, the sulphuric acid of the alum leaves it to combine with the lime to form sulphate of lime, and the alumina, which is insoluble, is precipitated, carrying with it suspended matter.

If the water contains little lime carbonate, if, that is to say, it is very soft water, it is advised that a little chloride of lime and carbonate of soda be dissolved in it before the alum is added. The sediment is then allowed to settle and the clear water drawn off. In a similar way will the addition of some astringent substances cause a purifying of water, such as chips of oak. Thus the muddy water of the Nile is clarified by rubbing the inside of the water vessel with bitter almonds, and in India the Hindoos rub the inside of the water-jar with the fruit of the *Strychnos potatorum*. The fruit is beaten into a paste, of which about 30 grains are used for 100 gallons of water, and it is allowed to act for 24 hours. Or one of the seeds is simply "rubbed for a minute or two round the inside of the vessel containing the water, generally an unglazed earthen one," and in a very short time the impurities fall to the bottom leaving the water clear and apparently wholesome. It is chiefly used for river water at the season when it is laden with suspended matters. Probably the effect produced upon the bitter waters of Marah by casting in the tree was similar to that of alum, oak chips, or the fruit of *Strychnos potatorum*.

Purification by Condy's Fluid.—When water contains a large quantity of organic matter, more than a filter can readily dispose of, and when no other water is easily procurable, it may be made tolerably safe and wholesome by means of permanganate of potash. Parkes advises as follows:—"In the case of any foul-smelling or suspected water, add good Condy's red fluid (that is, a solution of permanganate of potash), tea-spoonful by tea-spoonful, to 3 or 4 gallons of the water, stirring constantly. When the least permanent pink tint is perceptible, stop for five minutes; if the tint is gone, add 36 drops, and then, if necessary, 30 more, and then allow to stand for six hours; then add for each gallon 6 grains of a solution of crystallized alum, and if the water is very soft, a little calcium chloride and sodium carbonate, and allow to stand for twelve or eighteen hours. If not clear or if discoloured, filter through charcoal." In any case it will be well to filter through charcoal, as some of the organic matters may not be oxidized by the permanganate, and the filtration through charcoal may remove them.

Finally, it has been already mentioned how by boiling, or by the addition to water of a little unslaked lime, hardness of water may be greatly diminished, and how, by the addition of common soda, all hardness may be removed. The latter, however, must not be added to water to be used for drinking or such purposes.

Impure Water as a Cause of Disease.—Impure water may be a source of disease in a double way. It may produce simply a bad state of general health through its effect upon the digestive system, stomach, bowels, &c. Thus, there seems no doubt that vague ill-defined digestive troubles, dyspepsia, diarrhœa, sickness, dysenteric conditions, and so on, may arise from the use of impure waters. Such conditions may very often have such a cause when it is least suspected. It appears, moreover, that waters containing simply excess of inorganic salts, very hard waters, may occasion disturbance referred to the bowels, constipation, and so on. But, in the second place, water may be the medium of conveying specific disease. There is now no manner of doubt that water affords a medium for the propagation of typhoid fever and cholera, owing not to simple organic impurity, but to the specific poison of the disease gaining access to the water in sewage, containing the excreta of patients suffering from such diseases (see p. 187). Goitre has been shown to be associated with a particular kind of water (see p. 210), and various malarial diseases have their home in marshy places, where there is insufficient vegetation to employ the resources of the soil (see p. 427). Moreover, various forms of intestinal worms may be propagated by the ova of the worms gaining entrance to the water. This is illustrated in detail on p. 170. Now there is really no means of determining, as already stated, when an organic impurity in water is simply unpleasant and undesirable, and when it contains a specific poison capable of occasioning an epidemic. This is exceedingly well put in the following paragraphs from Wynter Blyth:—"Nothing is more clearly proved than the fact that a large population may drink a sewage-polluted water with the utmost impunity, under certain conditions. A few years ago the author proved that a town in Somersetshire had drunk a water-supply from shallow wells which was nothing more nor less than dilute sewage; and yet the death-rates from fever, from dysentery, and all other diseases supposed (and rightly supposed) to be propagated by water, were remarkably low in comparison with places drinking a pure water. Here, then, was an experiment ready made on more than a thousand persons, and the negative results recorded for the best part of a century. It proved that under ordinary conditions the water was harmless, and yet what chemist could pass such? The colour, taste, and smell, as well as the organic carbon, nitrogen, and microscopical characters, all combined to show that the characters of the supply were of great impurity; on the other hand, water of very moderate impurity, as shown by ordinary chemical and microscopical investigation, has many times been as fatal as a solution of some subtle poison. These, as it were, unconscious experiments continuously proceeding in towns, in villages, and in solitary homes, demand the closest study; and such a study will, in years to come, make clear the apparent discrepancy often existing between chemical and biological analyses. Possibly the conclusion already shadowed forth is this:—Water, however polluted by healthy human or animal sewage, nasty and abominable liquid as it may be, will produce no disease; water infected with the excretions from diseased natures will cause disease.

"Since, however, at the present time we cannot differentiate between those excrementitious matters which cause disease, and those which do not cause disease, *it is clearly safest to condemn as a supply a liquid which has been proved to be contaminated by a something, which, for ought we know, contains the seed of typhoid fever or of cholera.*"

Aerated Waters are waters which contain gas dissolved in them, so that the term might be applied to ordinary water, since it contains oxygen, nitrogen, and carbonic acid gas in solution. The term, however, is restricted to those waters which contain gas dissolved in them in such quantity, that when they are exposed to the ordinary atmosphere the gas comes off in bubbles, giving a sparkling quality to the water. Water is capable of dissolving any kind of gas to greater or less extent, but the most readily soluble of the ordinary gases is carbonic acid gas, and it is with this gas that the majority of aerated waters are charged. There are some natural waters, such as those of Seltz, Vichy, and Spa, which contain carbonic acid gas in such quantity that they effervesce in the open air, and such waters are called **natural aerated waters**. The carbonic acid gas is derived in their case from the ground, in which it exists in some districts in large quantities, specially in volcanic and limestone districts, being collected often in large volumes, because of difficulty of escape, and being, therefore, under great pressure. It is found at the bottom of deep wells and mines, in caverns, &c. Collections of it in mines are called "choke-damp," because of its suffocating character. The term "aerated waters," as commonly employed, however, means water which has been designedly charged with gas, usually carbonic acid, for the production of a pleasant sparkling beverage; and it is these **artificial aerated waters** that we shall consider here.

First of all it is needful to state a few of the characters of the gas.

Carbonic Acid Gas is produced wherever carbon or carbon-containing substances are burnt, being formed by the union of carbon with oxygen, in the proportion of one combining weight of carbon to two combining weights of oxygen, and it is, therefore, represented by the chemical formula CO_2. The gas consists, in round numbers, of 28 per cent carbon, and 72 per cent oxygen. The gas is also produced as a result of chemical changes going on in living structures, both vegetable and animal, the product of combustion occurring within them, ending in the liberation of heat and energy (see p. 527), and is given off in the gases of respiration as a waste product. Carbonic acid gas is likewise produced in all processes of fermentation and putrefaction. The ordinary processes of decay of animal and vegetable substances have as their ultimate object the oxidation or combustion of the complex organic body, and its consequent reduction to simple substances. This we have seen goes on in water, by the agency of the dissolved oxygen, and goes on by simple exposure to the air, even as it goes on, though with much greater rapidity, in a coal fire. In the course of fermentation it is one of the products, and it is because of its production that fermented beverages have their brisk, sparkling character, the gas being prevented from escaping. Carbonic acid gas may be readily produced in quantity, by acting on chalk or marble with dilute hydrochloric acid, or by heating chalk or marble to redness in an iron or earthen retort. Fig. 262 shows a very simple arrangement, which any one could make for himself, for the production of the gas. Into the flask is placed some marble, broken small, and then some muriatic or hydrochloric acid—spirit of salt, it is also called—diluted with water (1 part of the acid to 10 of water would suit). The gas at once proceeds to come off. The flask is now corked with a tightly-fitting india-rubber cork, through which passes a glass tube. The tube is bent downwards, and may dip into a vessel of water, through which the gas will then be seen to bubble. If, instead of ordinary water, the vessel contains lime water, as soon as the gas begins to bubble

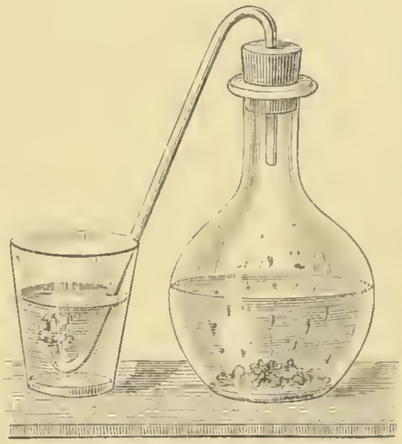
Fig. 262.—Arrangement for producing Carbonic Acid Gas.

through it, it will become milky, through the formation of carbonate of lime, which will not dissolve in water, and so is precipitated as a white powder. To make certain that the gas is obtained pure, instead of the vessel of water, substitute a second flask like the first, half fill it with pure water, and let the tube from the flask generating the gas pass through the cork, nearly to the bottom. Let a second tube pierce the cork, not being prolonged far into the flask. The gas will pass into the water from the first tube, bubble through it, being washed in course, and will collect, purified, in the upper part of the flask, from which it will escape by the second tube, and by a prolongation of the tube may be led wherever one wishes.

Carbonic acid gas is a heavy gas, more than 1½ times heavier than air, and it will consequently displace air, just as water will, and may be poured like water from one vessel to another. It is, however, colourless, and therefore invisible, and one, therefore, cannot tell when a jar has been filled with it. A very simple test will, however, settle that question. Suppose one wished to collect a jarful of the gas: all that is needful is to take the jar, or say a large wide-mouthed bottle, with a glass stopper, such as druggists employ, and having made certain of its cleanness, pass the tube coming from the apparatus, described above for washing the gas, down to the bottom of the bottle. The gas flows in, as water would, displacing the air. As soon as the bottle is full, it will flow over as water would. If a lighted taper be held close to the mouth of the bottle, as soon as the gas begins to flow over, the taper will be extinguished. The jar is then full, and if the stopper fits well and is securely fixed, its edges being slightly greased with lard to ensure perfect closure, the gas may be kept any time.

The extinction of the taper is due to the fact that the gas is incombustible. It is the product of combustion, and will not support combustion. Combustion cannot go on without oxygen, and as soon as the taper is surrounded by an atmosphere of the gas it receives no oxygen and therefore goes out. It is consequently a gas which, if breathed in any quantity, or if present to any great extent in the atmosphere inhaled, interferes with respiration, slowly, rapidly, or instantaneously, according to the extent to which it is present. It is, we have said, a heavy gas, and therefore collects at the bottom of wells, pits, &c. A man descending into such a well, without precaution, would be plunged into an atmosphere of the gas, and would at once fall unconscious, being extinguished like the candle flame. If the test already indicated were applied, and if the man, before deciding to descend, lowered a lighted candle, he could find by its extinction, or its continuing to burn, whether it was safe for him to descend. Not only does it interfere with respiratory processes going on in the body, when inhaled, but it also exerts a directly poisonous influence on the nervous system, so that an atmosphere containing plenty of oxygen for respiratory purposes would yet be poisonous, if it also contained a certain proportion of carbonic acid gas. (See next Section.)

Carbonic acid gas is very soluble in water, a certain bulk of water being able to dissolve an equal bulk of the gas. So that if a pint of pure water be introduced into a pint bottle filled with carbonic acid gas, the gas will all be dissolved in the water. The gas, like other gases, may be compressed, that is, when submitted to pressure, it can be made to occupy a smaller space. If a graduated cylinder, fitted with an air-tight piston, be filled with the gas, and then the piston pressed down with a pressure equal to that of the atmosphere, the gas will be compressed to one-half its bulk. If the piston were to be relieved of pressure it would be forced back to its original position by the expansion of the gas. Suppose the original pressure of the atmosphere is trebled, the volume of the gas would be reduced to a third. Now, even in this compressed state, water will dissolve its own bulk of carbonic acid gas, so long as the pressure is maintained. Thus, suppose a jar, fitted with a piston, and holding 4 pints of gas, and suppose at ordinary atmospheric pressure a pint of pure water to be introduced, the water would dissolve its own bulk of gas, namely, 1 pint. Suppose now a pressure equal to 15 lbs. to the square inch to be applied, that would reduce the 4 pints of gas to 2 pints, 1 pint of which (its own bulk) the water would dissolve, and thus the piston would come down half-way in the jar, the remaining half being occupied by the pint of water with 2 pints of gas dissolved in it, and the pint of compressed gas representing 2 original pints. Or suppose at first the pressure on the piston had been equal to four times the atmospheric pressure, that would have reduced the bulk of the gas to 1 pint, and this 1 pint would be dissolved by the pint of water, so that with this pressure the piston would sink to the level of the surface of the water, all the gas being dissolved. Under great pressure, then, water can be caused to dissolve a very large quantity of carbonic acid gas. If the pressure be diminished, a proportion of the gas will be given off, and, if all the extra pressure be removed, all the gas will be evolved with effervescence, except what the water would dissolve under ordinary atmospheric pressure. Even this may be driven off if the water is heated. The reason of the effervescence of aerated water as soon as the cork is removed is evident from these explanations, as well as the bursting in summer weather of bottles containing such water.

The various aerated waters in common use consist of water charged under pressure with carbonic acid gas, to which also some particular flavouring agent has been added.

In aerated water manufactories the gas is prepared in large cylinders from chalk by the action of an acid. It is then purified by being passed through a series of vessels which rid it of foreign gases, the last of the vessels containing pure water. Thence the gas is passed to a gasometer of large size, where it is stored under a pressure of several atmospheres. From this gasometer the gas is carried by a tube to a cylinder in which pure water is contained. The gas is mixed with the water by agitation under pressure, and a sufficient quantity of gas forced into the water till a permanent pressure of twice the ordinary atmospheric pressure is reached. Simple aerated water, which is frequently called soda water, is this water charged with carbonic acid gas, without any other addition. It is run into bottles by means of a special tap and other arrangements, which prevent the escape of the gas. By means of the bottling machines now in use, the water can be bottled with extraordinary rapidity and little loss. During all the stages of the manufacture the mode of transference of gas from one cylinder to another is arranged to prevent any atmospheric air gaining admittance. Into the charged cylinder the appropriate quantity of bicarbonate of soda, potash, &c., can be introduced, if actual aerated soda water or potash water is required.

Soda Water.—As already explained, many people speak of soda water when they mean simply aerated water. Actual soda water contains 30 grains of bicarbonate of soda to every imperial pint of water, that is, each ordinary bottle, which holds ½ pint, should contain 15 grains of bicarbonate of soda in solution. The British Pharmacopœia directs that the quantity of gas with which it is charged should sustain a pressure of seven atmospheres.

Potash Water should contain 30 grains carbonate of potash to each pint.

Lithia Water contains 10 grains carbonate of lithium per pint.

Lemonade is simply aerated water passed into a bottle, into which there has been previously put a small quantity of syrup, flavoured with lemon. There are many other drinks, exactly similar in character, varying only in the flavour which has been imparted to the syrup, such as gingerade, orangeade, and drinks flavoured with raspberry vinegar, and other fruit syrups. Gingerade is usually slightly coloured, and has added to it some mucilaginous material, which prevents the too speedy escape of the gas when it is drawn, and thus causes the more permanent "head" to appear, which the public thinks the appropriate quality of gingerade in particular.

Ginger Beer is really an alcoholic beverage, and is considered under alcoholic drinks.

Oxygenated Water, that is water which is charged with oxygen under pressure, has recently come into use, and it is said to have an exhilarating effect, and to be useful in cases of diabetes, as well as in some forms of indigestion, sluggish liver, and so on. Water, it is to be noted, dissolves oxygen much less freely than carbonic acid gas.

These aerated waters are pleasant beverages possessing little properties beyond that of ordinary water. The escape of the gas produces a sharpish, pleasant taste, and has a gentle stimulating action on the stomach, while the gas itself is somewhat soothing, and is often exceedingly grateful in cases of irritable stomach.

Contamination of Aerated Waters.—The quality of aerated waters depends naturally upon the quality of the water used in their manufacture. Aerated waters may, therefore, be very unwholesome, owing to organic or other impurity, if the manufacturer has not been scrupulously careful as to the source and condition of the water used. Supposing, then, that the water is pure, the risk is contamination with lead, for carbonic acid gas very readily attacks lead, and if in any part of the apparatus, used for the manufacture, a lead joint or a lead surface of any kind is exposed, the water will rapidly dissolve some of the metal. Lead poisoning from such sources are not by any means unknown. Tinned copper cylinders are usually employed in the manufacture to prevent this. But further contamination may arise from the syphons in which aerated waters are now so commonly sold, or gazogenes in which aerated waters in small quantities are made in households. The attachment of the glass tube which passes down the inside of the syphon, being often made of pewter, leads to this risk.

The detection of lead in aerated water may be made in the way noted (on p. 648) for its detection in water.

Mineral Waters.—These being medicines rather than beverages, are discussed in the part devoted to drugs.

TEA, COFFEE, COCOA, CHOCOLATE, &c.

Tea, coffee, cocoa, and many other substances used for the preparation of drinks, have several common features, of which it may be well to take general notice before considering each of the substances in detail.

1. They all contain an active principle, or alkaloid, containing nitrogen, akin to the active principle atropin, of the deadly nightshade (belladonna), akin to strychnine, to quinine, and to nicotine, the active principle of tobacco. In the case of tea this active principle is **thein**, in the case of coffee it is called **caffein**, and in the case of cocoa, **theobromin**, but the two former are apparently identical.

2. They all possess an aromatic oil, on which the flavour or aroma of the infusion depends. This oil does not exist in the substances in their fresh state, but is produced in the drying and roasting processes followed in their preparation for the market.

3. Tea and coffee contain an astringent substance, tannin in the case of tea, and a modification of tannin in the case of coffee. It does not exist in cocoa, or at least is present only in very small quantity.

4. Besides these there exists a variety of substances which are of no moment from the point of view of those who are considering their value as beverages, however interesting they may be to the analytical chemist. These substances are albuminoids, gum, dextrin, fat, wax, colouring matters, woody fibre, and mineral matters.

The active principle, aromatic oil, and astringent substance are worth fuller consideration.

Thein, or Caffein, for the two are identical, was discovered in coffee-berries in 1820. It had been previously discovered by Leeuwenhoeck, whose remarkable microscopic work has been referred to on p. 385, but had been afterwards overlooked. It is found not only in the coffee-bean but also in the leaf of the coffee-plant. In tea it was discovered in 1827, but it was not till eleven years later that the active principle of coffee, which had been called caffein, and that of tea, which had been called thein, were found to be one and the same substance. In 1841 the active principle of cocoa was discovered. It very much resembles thein. It is owing to the presence of this active principle that all these substances possess their stimulating property. Other substances used in a similar way to tea, coffee leaves, for example, Maté or Paraguay tea, and the kola-nut, also possess the same active principle as tea. "It is remarkable," says Attfield, who discovered the presence of thein in the kola-nut, "that the instinct of man, even in his savage state, should have led him to select, as the bases of common beverages, just the four or five plants which out of many thousands are the only ones, so far as we know, containing thein."

Thein can be obtained in fine white needle-shaped crystals, and may be easily separated by anyone who cares to take a very little trouble. Put a few finely-powdered leaves into the bottom of a clean cold test-tube, add a little water, and boil over a spirit-lamp till the water is nearly all driven off. Add a pinch of dry magnesia, and mix with the leaves, with the aid of a glass rod, into a sort of paste. Then gently warm the bottom only of the tube in the flame of the spirit-lamp. The thein will be driven off and will be deposited on the upper cold part of the tube in fine needles, where the naked eye will be able to perceive them, and a magnifying-glass will make them very distinct. The same process may be carried out in a tea-spoon over a gas flame, a slip of cold glass being held over the spoon to condense the crystals.

Thein has no smell but a slightly bitter taste. Its effects upon the healthy human body have been tested directly. In small doses it accelerates the pulse and the breathing, and quickens ordinary muscular movements. It increases the action of the skin, and apparently also of the kidneys. It also excites the nervous system, quickening thought. In fact it produces in small doses those effects, the experience of which has led a cup of tea to be the unfailing resort as a cheering and gently-stimulating beverage. It diminishes the tendency to sleep and removes some forms of headache. In large doses it acts as a poison, producing nervous excitement, trembling of hands and arms, and restlessness, and ultimately narcotic effects. A dose of 4 grains is fatal to a cat, nervous symptoms being prominent. A full tea-spoonful of tea would yield from 1 to 3 grains of thein—probably on an average about 2½ grains.

Theobromin is chemically related to thein. Its poisonous action is not so pronounced, though 15 grains proved poisonous to kittens.

The aromatic oil of tea is of a citrin-yellow colour, with a strong aroma of the tea. It is produced in the drying of the tea, by some unknown chemical change the processes induce. The oil is volatile. In the case of coffee it is produced during the act of roasting; and if the roasting be unskilfully done, the oil produced may be driven off. Persons who roast their own beans require a little practice to enable them to hit the point when the highest degree of flavour has been produced, and the least given off. Many people wonder why the coffee gave out such a delicious odour when being roasted, and why the infusion was so devoid of flavour—the reason being that they had dissipated the essential oil in the atmosphere. The essential oil of cocoa is also a product of the roasting. It is contained in smaller amount than in tea or coffee. The action of the aromatic oils has not been very thoroughly investigated, but Johnston thinks that, besides conferring the aroma on the tea, coffee, &c., it most likely exercises a narcotic influence, rendered probable by many known facts. "Among these I mention the headaches and giddiness to which tea-tasters are subject, the attacks of paralysis to which, after a few years, those who are employed in packing and unpacking chests of tea are found to be liable; and the circumstance that, in China, tea is rarely used till it is a year old, because of the peculiar intoxicating property which new tea possesses. The effect of this keeping upon tea must be chiefly to allow a portion of the volatile ingredients of the leaf to escape. And lastly, that there is a powerful virtne in this oil is rendered probable by the fact, that the similar oil of coffee has been found by experiment to possess narcotic properties." The essential oil of coffee gently stimulates the skin and bowels, and also the nervous system.

The astringent constituent of tea is tannin, a constituent also of oak bark and many other plants. It is this ingredient which produces the bitter astringent taste, so well marked specially in a long-standing infusion. It also confers upon tea somewhat of a constipating effect, more notable when tea is used strong and dark. It has been supposed to be the tannin also which makes tea rather apt to produce indigestion, but Dr. Roberts of Manchester is inclined to think that this property is due to other acid constituents, and not to the tannin. It is quite certain, however, that if strong black tea, long infused, be habitually taken, the tannin exercises an injurious influence on the mucous membrane of the stomach, owing to its astringent action. Caffeic or caffeo-tannic acid is the modification in which the astringent principle is present in coffee, though it is contained in considerably less quantity than the tannin of tea. In some cocoas tannin is present in exceedingly small amount, and in others apparently not at all.

We shall now consider tea, coffee, &c., separately, their general features, possessed in common, having been noted.

Tea is the product of a plant, *Thea sinensis*, belonging to a section of the genus *Camellia*, of the natural order *Columniferæ*, of which there are three main varieties, *Thea viridis* (Fig. 263) and *Thea bohea* (Fig. 264), native to Bengal and parts of China, and *Thea assamica*, native to Assam. The two former supply the China teas, and the latter Indian teas. The plant, it is believed, was really introduced to China from India, as early as the sixth century of the Christian era. In the eighth century it was introduced to Japan, and in the beginning of the seventeenth to Europe, and about the middle of the seventeenth century it reached Britain. The plant is a hardy evergreen flowering shrub, five or six feet high, though by cropping the upward growth is kept down to about three feet, and the lateral growth thus encouraged. If left alone it would grow to the dimensions of a tree. The plant is grown from seed, sown in March, the seed being kept during the previous winter in moist earth. The year-old shrubs are planted out in rows, a space of three or four feet intervening between each row. The leaves are not removed till the fourth or fifth year. Thereafter three or four crops are taken each year, the first in early spring, the second at the beginning of May, the third about the middle of June, and the fourth in

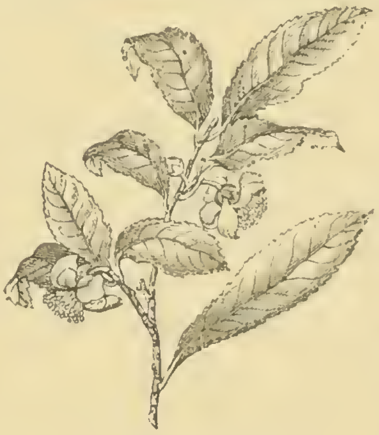
Fig. 263.—Thea viridis.

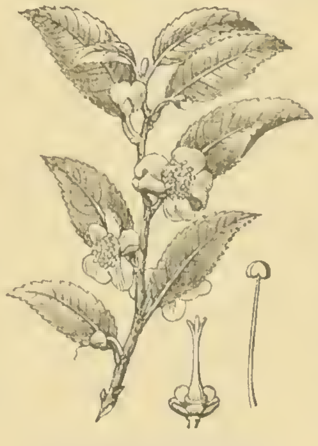
Fig. 264.—Thea bohea.

August. The first leaves, however, are the finest, and have the most delicate flavour. The leaves of the later gatherings are larger, more woody and bitter. The qualities of tea vary much, according to the period of the gathering, and according to the climate, soil, and other circumstances, the preparation of the leaves for the market very materially affecting the quality. The leaves are plucked by hand, women and girls being employed in the work. Four pounds of the green leaves yield one pound of dried tea. The mode of treating the fresh leaves depends on whether green tea or black is to be produced, the difference being one simply of preparation. To obtain green tea, the fresh leaves are spread out in thin layers on flat bamboo trays for from one to two hours, to allow them to dry slightly. They are then thrown into roasting-pans, heated over a wood fire, where they are moved rapidly about and become moist and flaccid and give off considerable vapour. In a few minutes they are transferred to a table, where they are rolled by hand. A second time they are put into the pan, over a slow charcoal fire, in which they are kept in rapid motion by hand, and in from an hour to an hour and a half, perhaps after a second rolling, they are finished. They are of a green colour, which subsequently brightens, the change of colour to black being prevented by the rapid roasting. Thereafter the tea is winnowed and separated into the various qualities and refired. When it is desirable to produce black tea, the leaves are allowed to lie in heaps for twelve hours or so, during which a species of fermentation occurs, which changes the natural hue of the leaf to a dark colour. Thereafter the various processes of drying, rolling, and roasting are carried out. The processes are thus described:—The leaves, after being brought in from the plantation, "are spread out upon large bamboo mats or trays, and are allowed to lie in this state for a considerable time. If they are brought in at night they lie till next morning. The leaves are next gathered up by the workmen with both hands, thrown into the air, and allowed to separate and fall down again. They are tossed about in this manner, and slightly beat or patted with the hands for a considerable space of time. At length, when they become soft and flaccid, they are thrown in heaps, and allowed to lie in this state for about an hour, or perhaps a little longer. When examined at the end of this time, they appear to have undergone a slight change in colour, are soft and moist, and emit a fragrant smell. The rolling process now commences. Several men take their stations at the rolling table and divide the leaves among them. Each takes as many as he can press with his hands, and makes them up in the form of a ball. This is rolled upon the rattan-worked table, and gently compressed, the object being to get rid of a portion of the sap and moisture, and at the same time to twist the leaves. These balls of leaves are frequently shaken out, and passed from hand to hand until they reach the head workman, who examines them carefully to see if they have taken the requisite twist. When he is satisfied of this, the leaves are removed from the rolling table, and shaken out upon flat trays, until the remaining portions have undergone the same process. In no case are they allowed to lie long in this state, and sometimes they are taken at once to the roasting-pan. The next part of the process is exactly the same as in the manipulation of green tea. The leaves are thrown into an iron pan, where they are roasted for about five minutes, and then rolled upon the rattan table. After being rolled the leaves are shaken out, thinly, on sieves, and exposed to the air out of doors. A framework for this purpose, made of bamboo, is generally seen in front of all the cottages among the tea hills. The leaves are allowed to remain in this condition for about three hours: during this time the workmen are employed in going over the sieves in rotation, turning the leaves and separating them from each other. A fine dry day, when the sun is not too bright, seems to be preferred for this part of the operation. The leaves having now lost a large portion of their moisture, and having become considerably reduced in size, are removed into the factory. They are put a second time into the roasting-pan for three or four minutes, and taken out and rolled as before. The charcoal fires are now got ready, a tubular basket, narrow at the middle and wide at both ends, is placed over the fire. A sieve is dropped into this tube, and covered with leaves, which are shaken on it to about an inch in thickness. After five or six minutes, during which time they are carefully watched, they are removed from the fire and rolled a third time. As the balls of leaves come from the hands of the rollers, they are placed in a heap until the whole have been rolled. They are again shaken on the sieves as before, and set over the fire for a little while longer. Sometimes the last operation—namely, heating and rolling—is repeated a fourth time; the leaves have now assumed a dark colour. When the whole have been gone over in this manner, they are placed thickly in the baskets, which are again set over the charcoal fire. The workman now makes a hole with his hand through the centre of the leaves, to allow vent to any smoke or vapour which may rise from the charcoal, as well as to let up the heat, which has been greatly reduced by covering up the fires. The tea now remains over the slow charcoal fire, covered with a flat basket, until it is perfectly dry, carefully watched, however, by the workman, who every now and then stirs it up with his hands, so that the whole may be equally heated. The black colour is now fairly brought out, but afterwards improves in appearance. The after processes, such as sifting, picking, and refining, are carried on at the convenience of the workmen" (Fortune).

The quality of tea, as has been said, depends not only upon soil, cultivation, and preparation, but also upon the picking. The first crop, consisting of the young leaves, just bursting or barely expanded, and buds, is the finest. It is called Pekoe, which means white down, or Flowery Pekoe, because of the fine hairs or down clothing the leaf. Congou, Souchong, and Caper are other qualities of black tea. "Caper is in hard grains, made up of the dust of the other varieties cemented together by means of gum." Bohea is the commonest description, scarcely now found in the market. Twankay, Hyson Skin, Young Hyson, Hyson, and Gunpowder are various qualities of green tea, the Gunpowder being the finest quality, prepared from similar pickings to Pekoe. Some of the highest qualities of teas do not reach the market as such, being kept for blending. Various sweet-smelling plants are used for scenting teas, the sweet-scented olive for example, and thus there are scented Caper, orange-scented Pekoe, and so on.

The composition of tea is stated by Koenig as follows:—

Water	11·49	per cent.
Thein	1·35	,,
Essential oil	·67	,,
Tannin	12·36	,,
Nitrogenous substances	21·22	,,
Fat, colouring matter: wax, gum, dextrin	10·75	,,
Other non-nitrogenous substances	16·75	,,
Woody fibre	20·30	,,
Ash	5·11	,,

In other analyses the thein is stated as 2·0 per cent, 2·5 per cent, 3 per cent, and even more, the quantity varying with the quality of the plant, and in the same way the quantity of the essential oil varies, while the tannin, according to some, is as high as 15 per cent. It is worthy of notice that the quantities of the chief substances vary with the age of the tea leaf, the young leaves containing more water, but also more thein than the old leaves, while the latter contained more tannin and salts. It is well to contrast these quantities with those of the same constituents in coffee and cocoa, in the former of which the thein scarcely reaches 1·5 per cent, in some kinds falling as low as ·6 per cent, while the aromatic oil is only about a $\frac{3}{1000}$th per cent, and the tannin may reach only 4 per cent, while in the latter the theobromin is 1·5 per cent, and the aromatic oil is too small in quantity to be stated.

The nitrogenous substances, it might be supposed, would be of value as food; but it must be remembered that only an infusion of the leaf is commonly used, and that in boiling water the large proportion of albuminoids is insoluble, so that they are not consumed in any quantity. It has been found, for example, that half a pint of tea, made from a large tea-spoonful of the dry tea, will dissolve only about 38 grains of the material of the leaf, of which the tannin is stated at about 7½ grains, and the thein 2½ grains, while the mineral substances would be about 6 grains, leaving only 22 grains as the total of gummy, sugary, and nitrogenous substances extracted. The value of these 22 grains is, of course, not worth considering. The mineral substances consist principally of potash salts, magnesia and lime salts, phosphoric acid being also present in considerable amount.

The Value of Tea as a Food-stuff. As an example of the composition of a cup of tea, and an illustration of its valueless character as a food-stuff, that is as supplying anything for the repair of wasted tissue and yielding of energy for work or heat, I quote the following table from Attfield:—

Constituents of One Cup (seven ounces of Tea) containing average amounts of Cream (½ oz.) and Sugar (100 *grains*).

	Grains.
Cheesy matter from the cream	5
Fat and milk sugar ,, ,,	30
Added sugar	100
Mineral matter of the cream	1
Extract of tea leaf (mineral matter 4¾; organic 16¼)	21
Total	157

The small quantity really derived from the tea is striking; and if one takes no sugar the total amount of dissolved solids is only 57 grains, while probably half the quantity of cream stated here is all that is usually taken. Tea, therefore, cannot be considered as yielding anything in the nature of nutriment to the body. It is simply a pleasant beverage, being used entirely for the effects due to its essential oil and active principle. The action of thein and the essential oil, given separately, has been already considered. It has been said that while tea supplies no nutriment to the body, it yet diminishes tissue waste, and thus saves the consumption of food to a slight extent, chiefly by the action of the thein. Johnston puts it thus: "The introduction into the stomach of even a minute proportion of thein—three or four grains a-day—has the remarkable effect of sensibly diminishing the absolute quantity of waste products of the tissues voided in a day by a healthy man, living on the same kind of food, and engaged in the same occupation, under the same circumstances. This fact indicates that the waste of the body is lessened by the introduction of thein into the stomach—that is, by the use of tea. And if the waste be lessened, the necessity of food to repair it will be lessened in an equal proportion. In other words by the consumption of a certain quantity of tea, the health and strength of the body will be maintained in an equal degree upon a smaller supply of ordinary food. Tea, therefore, saves food—stands to a certain extent in the place of food—while at the same time it soothes the body and enlivens the mind." I have quoted this, not because it is a reliable view of the part played by tea in the body, but because if I had stated simply the results of later experiments, some who have read Johnston's work might think I had overlooked so pronounced an opinion. For his opinion is based on a quite inadequate view of the case. Though tea diminishes tissue waste, it may nevertheless quicken the consumption of such foods as yield energy for work and heat. For if the reader will look back to p. 539 he will find that the urea cast out of the kidney is taken as a measure of tissue waste, and it is this that Johnston refers to, while the carbonic acid gas given off by the lungs is the means of estimating the consumption of fats, starches and sugars for yielding energy, and this portion of the case he has entirely overlooked. Now Dr. E. Smith, subsequent to the publication of the opinion I have quoted, made a series of experiments to determine the effect of tea on the quantity of carbonic acid given off by the lungs. He found in every case that it was markedly increased, and in his paper, published in the *Philosophical Transactions* of 1859, he states the exact figures. Now this increase implies increased consumption in the body of the energy-yielding foods, fats, starches, &c. This is quite consistent with the admitted fact that tea quickens the movement of the heart and the rapidity of the breathing, and increases the amount of heat given off from the body by the gentle stimulus to perspiration. So that even though it diminishes the waste of tissue it increases the waste of fuel, so to speak, and the result of the whole is an actual need for more food. Dr. Smith sums up the case thus: "Hence, in reference to nutrition, we may say that tea increases waste, since *it promotes the transformation of food without supplying nutriment, and increases the loss of heat without supplying fuel*, and it is therefore specially adapted to the wants of those who usually eat too much, and after a full meal, when the process of assimilation should be quickened, but is less adapted to the poor and ill-fed, and during fasting." Tea is, then, to be regarded as a stimulant, but as in no sense fitted to act as or take the place of a food. As a stimulant, however, it is a most valuable agent. Its exhilarating effect, which leaves no after depression, and entitles it to the praise of cheering without inebriating, is most useful for those engaged in intellectual work, to drive off drowsiness, and aid in removing feelings of languor and fatigue. But it is just those excellent qualities that render it most liable to abuse, when people are led by them to resort to it in states of exhaustion, when what their bodies are demanding is supplies of nourishing food, and when its stimulating properties are used to hide for the time the inadequacy of a poor or improper meal. There can be no manner of doubt that the rapid growth of tea consumption among the poorer classes, among many of whom it is found as a constituent of every meal, is doing great harm to their physical well-being. For it is supplanting far more nourishing diets, than the ordinary tea, bread and butter and bacon, &c. can ever make, and its cheering properties prevent that fact being recognized. If the meal be otherwise plentiful and nourishing, there can be no objection to a cup of tea if such is desired, and taken thus as an adjunct to the morning and evening meal it is pleasant to most people. If it is taken too frequently, however, in too large quantities or too strong, the injurious effects of thein and tannin begin to show themselves in the nervousness and tremors or in the dyspeptic stomach of the tea-drinker to excess. These bad effects are more speedily observed in those who use green teas constantly.

As a stimulant, accelerating muscular movement, and as a restorative during fatigue, tea is highly spoken of by army medical officers and generals who have commanded in the field. Parkes says of it: "As an article of diet for soldiers tea is most useful. The hot infusion, like that of coffee, is potent against both heat and cold, is most useful in great fatigue, especially in hot climates, and also has a great purifying effect on water. Tea is so light, is so easily carried, and the infusion is so readily made, that it should form the drink *par excellence* of the soldier on service." There is also a belief that it lessens the susceptibility to malaria, but the evidence on this point is imperfect.

The influence of tea on digestion has been shown on p. 603. Its slowing effect is supposed to be due to the tannin, but Roberts believes it to be due to certain acids, and to be got rid of by adding a pinch of soda.

The best way to infuse tea is to pour boiling water over the leaves in a hot cup, cover with the saucer, and allow to stand from 3 to 5 minutes. The infusion is then poured off, and no further water should be poured on in the endeavour to extract more from the leaves. "The semi-exhausted leaves are thrown away; a connoisseur never ventures on a second brew." The infusion so prepared has the delicate aroma of the plant, but wants the body and "grip" that many people think as desirable in tea as in whisky. It is a method open also to the charge of extravagance. Soft water extracts more soluble materials than hard water, and it is always proper to soften hard water with a pinch of bicarbonate of soda before using it for tea.

Adulterations of Tea.—Attfield says that owing to the vigilance of the custom-house officials adulterated tea seldom or never gains access to Britain, and is rarely, if ever adulterated afterwards; the abolition of duty has also favoured this state of affairs, though, of course, very inferior qualities are sent to market still. Formerly, however, adulteration was extensive, leaves of other plants being used, and such foreign leaves are still found. The leaves of *Camellia Sasanqua* and *Chloranthus inconspicuus* were said to be used in China, and in this country willow, sloe, oak, valonia oak, plane, beech, elm, poplar, hawthorn, elm, and horse-chestnut leaves were used, treated with gum and catechu and coloured. These could be detected by softening and spreading out the leaves on glass slides and observing the character and direction of the veins in each leaf. The border of the tea leaf is serrated, the primary veins run out from the midrib nearly to the border, and then turn in, a distinct space between them and the border being left. Exhausted leaves treated with gum and colouring matter were also used, whose presence required an analysis to show their deficiency in thein and tannin. What the Chinese called lie-tea was also largely used to adulterate. It consisted of the sweepings of the tea-houses, tea-dust, mixed with sand and often the magnetic oxide of iron, and made up into different forms with a solution of starch, to imitate various kinds of tea, especially gunpowder. A lens shows their true characters, and when some of the lie-tea is put into hot water, the binding material is loosened, and the little masses fall to pieces, showing their real nature. Tea and especially green tea was also faced or coloured, Prussian blue, mixed with gypsum, indigo, &c., were used for this purpose, the colour being added in the roasting-pan. This was done to meet the demand for a uniform and prettier colour. The actual quantity of colour would be very little, a third or fourth of a grain of the colouring matter per ounce of tea, but was still an undesirable addition. It could be detected by shaking tea up with cold water and throwing it on a piece of muslin over a glass. The colour will pass through the muslin and settle in the bottom of the glass. The water is poured off, and the colouring matter obtained. Black-lead was also used for black teas. Dr. Hill Hassall says "It will be a satisfaction to learn that the great bulk of the ordinary black teas, the Congous and Souchongs, consumed in this country, are free from admixture with foreign leaves and all other adulteration. The foreign leaves, when employed, are found principally in very low-priced and much-broken teas, and in the lower qualities of black and green gunpowder teas."

Paraguay Tea or **Maté** is prepared from the leaves of Brazilian holly (*Ilex paraguayensis*), which are dried and roasted, the whole stem and branches being cut down for the purpose. During the roasting the peculiar flavour is developed as in tea and coffee. The stems, leaves, &c., are then pounded to coarse powder in pits dug in the earth, sorted, packed in bullock-skins and set in the sun to dry. There are various qualities of it sold, according as it consists mainly of new leaves and young shoots, or leaves without twigs and stalks, or large old leaves with twigs and fragments of wood. Maté contains on an average 1·3 per cent of thein, 16 per cent of tannin, and a very small fraction of aromatic oil.

For the preparation of the infusion boiling water is poured on a tea-spoonful of the powdered leaves in a cup, a little sugar is added, and the liquid is sucked through a reed called a "bombilla." It has a narcotic action on the nervous system, and seems also to possess restorative and refreshing properties, valuable after great fatigue. It is used very extensively in Peru, Paraguay and Brazil, and people become as addicted to it as opium-eaters to their drug.

Bohemian Tea is prepared in Bohemia from the leaf of the common *Gromwell* (*Lithospermum officinale*), of the borage order of plants. It is used for adulterating ordinary tea, but contains none of the active ingredients of ordinary tea.

Coffee is prepared from the seed-beans of the coffee plant, *Caffea arabica*, of the natural order Cinchonaceæ, the same order which yields the tree from which Peruvian bark, quinine, ipecacuanha, &c., are prepared. The tree is small, shrub-like (Fig. 265), and a native of Abyssinia. It was introduced into Arabia in the fifteenth century, and the first coffee-shop was opened in London in 1652. The plant is sown in nurseries, transplanted when six months old, comes into full bearing in three years, and bears under favourable circumstances for twenty years. It is now extensively cultivated in Arabia, Ceylon, the East and West Indies, Brazil, and Central America. The fruit of the coffee tree, "which presents a superficial resemblance to a red cherry," contains two seeds, from which the pulp and covering are stripped, and which are then dried. It requires roasting for the development of the powerful volatile and aromatic oil, which gives the coffee its flavour, and which is not present, as such, previous to roasting.

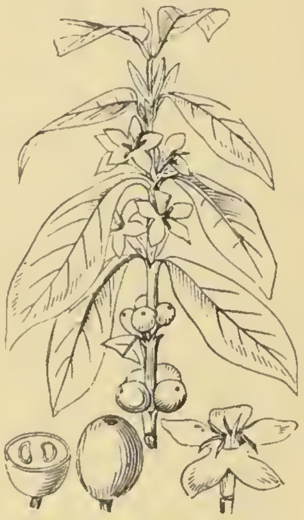

Fig. 265.—Coffee Plant (*Caffea arabica*).

The composition of Coffee is given by Church as follows:—

Water	5·0 per cent.
Thein (Caffein)	0·6 ,,
Tannin	4·0 ,,
Nitrogenous	15·0 ,,
Gum, Colouring Matter, &c., and other extractives	34·4 ,,
Fibre	36·4 ,,
Saline	4·6 ,,

The contrast between the amount of thein and tannin in coffee and the amount in tea has been already commented on. The aromatic oil is in so infinitesimal quantity that it has not been mentioned in the above analysis. Yet though it is in so small a quantity as to be with difficulty estimated, one part in fifty thousand, it is in this that the commercial value of the coffee depends. If the oil could be bought for the purpose of imparting the flavour, so as to add to the value of coffees of inferior aroma, it would, according to Payen, be worth £100 sterling an ounce. This oil appears to be developed by roasting to a greater extent in old than in new beans. All kinds of coffee-beans improve in their flavour by keeping, the small Mocha berries ripening in three years, but it is said that the coffee-beans with poorest flavour will, if kept for a sufficiently long time, ten to fourteen years, acquire as good a flavour as the best.

In the process of roasting, the berries swell and lose weight, 112 pounds of raw coffee being reduced to 92 pounds of roasted coffee. A chestnut-brown colour should be produced by roasting, a burnt flavour being produced when the process is overdone. Roasted coffee loses its aroma, if exposed to the air, and this it will do completely in two to four months. The coffee-drinker always prefers his coffee freshly roasted and ground. The infusion may be prepared much as tea is. Boiling drives off some of the aromatic oil, and makes the infusion deficient in flavour, while less than boiling does not extract from the ground coffee all that might be. It has, therefore, been recommended that the "grounds" from a previous infusion should be kept, that when a fresh supply of coffee is to be prepared, these "grounds" should be well boiled in water, and the hot decoction thus obtained poured over the fresh coffee, and be allowed to stand for from five to fifteen minutes, and then poured off, the "grounds" of this being retained for the next infusion. Thus both body and flavour would be secured. Coffee yields more extractives to soft than to hard water; to the latter a pinch of bicarbonate of soda should be added.

Constituents of a Breakfast-cupful of Coffee with ¾ oz. of Cream and ¼ oz. Sugar.

	Grains.
Cheesy matter from the cream	7½
Fat with sugar from milk and from seed	41
Added sugar	140
Extract from coffee seed (mineral 11; organic 41)	52
Mineral matter in cream	1½
Total	242

The action of coffee upon the body is similar to that of tea. It does not supply any nutriment worth considering, as the table showing the constituents of a cup of coffee indicates. Containing as it does less thein, more can be consumed than of tea, and the marked decrease in the amount of tannin renders it less liable to interfere with digestion. It was supposed that coffee diminished tissue change, as had also been alleged of tea. This has been shown to be inaccurate. It acts as a stimulant upon the nervous system, and upon the heart, and it increases the rate of breathing, and the amount of carbonic acid expelled. It acts also upon the kidneys, increasing the amount of water expelled by these organs. It tends also to produce a relaxing effect upon the bowels, while the effect of tea is rather binding. The active principle, thein or caffein, is an excellent remedy for nervous headache, given in from 1 to 3 grain doses. In excessive doses coffee acts injuriously upon the nervous system as does tea, producing brain excitement, nervous tremors, and wakefulness.

Coffee is especially useful during fatigue, as it invigorates without producing depression later; and it has marked power in relieving the feeling of hunger. It readily induces indigestion in the case of the dyspeptic, but not so readily as tea. Its stimulating effects are very useful in opium-poisoning, in nervous headache, and in other conditions. It often relieves the spasm of asthma.

Chicory is commonly added to coffee to give it increased "body." This is the root of the wild succory or wild endive (*Cichorium Intybus*), belonging to the natural order Compositæ, as do the dandelion and lettuce. It is extensively cultivated in Germany, Holland, and Belgium for this purpose. It grows wild in Britain, by the roadside, blossoming with pale-blue flowers in August and September, the stem rising from 1 to 3 feet in height. It has a long taproot like parsnip, white and fleshy, containing a milky bitter juice. The root is used before the blossoms are due, being cut into pieces, kiln-dried, roasted in revolving iron cylinders, with lard to the extent of 2 lbs. for every hundredweight of the dried root, and ground. Thus prepared it markedly resembles coffee, and contains a volatile oil giving aroma, but not of the character of the volatile oil of coffee, and it contains some bitter material, but no such tannic acid as is found in coffee and no caffein. It gives increased colour to coffee and strengthens the flavour, and its addition is desired by many people. In Germany it is much used, as much as 5 lbs. per head of the population being consumed in Belgium. It is not unwholesome, if used in small quantities, but it appears to act upon the bowels, tending to produce diarrhœa, and is apt to cause pain in the stomach, flatulence, &c. The presence of chicory in coffee can be detected by pouring some of the coffee on *cold* water in a wine-glass. Coffee floats for a long time, whereas chicory sinks at once. Moreover, coffee does not colour cold water, and chicory does.

Chicory is itself adulterated, roasted corn, wheat, beans, acorns, mangold-wurzel, dandelion-root, and various red earths being used for this purpose.

Coffee leaves have long been used in the Eastern Archipelago to yield a kind of tea. The leaves are roasted over a clear fire, then separated from the twigs, from which, after a second roasting, the bark is removed and mixed with the leaves. They make a clear brown infusion, which is drunk with cream and sugar like tea, and have a fragrant odour resembling a mixture of tea and coffee. In Sumatra this forms "the only beverage of the whole population," being preferred to the infusion of the berry. The leaves contain 1½ per cent of thein, as well as a volatile oil, and some astringent substance. According to Dr. E. Smith, the infusion does not excite either the pulse or breathing, but decreases both; and he accordingly thinks there is no probability of them supplanting either tea or coffee in the duty they perform in the human body.

Cocoa (Fig. 266) is the seed of a tree, the *Theobroma Cacao*, native to Mexico, West Indies, and South America, and it is chiefly grown in Brazil, Guiana, and Trinidad. Forests of it are grown in Demerara; it belongs to the natural order Byttneriaceæ. The fruit of the tree is of the shape of a small cucumber, and contains a sweetish pulp, in which 50 to 100 seeds are imbedded, arranged in rows, with partitions between them. The ripe fruit is collected in heaps on the ground or in earthen vessels, during which it undergoes a fermentive change, which develops an aromatic smell, and becomes soft. The seeds are then removed, cleaned, and dried in the sun. They are dark-brown in colour, and almond shaped. For use they are roasted in

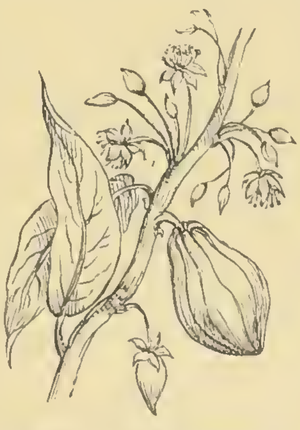
Fig. 266.—Cocoa (*Theobroma Cacao*).

iron cylinders, which develops the aroma. Deprived of the husks and simply crushed, they form **cocoa-nibs**, the purest kind of cocoa obtainable. The bean, after roasting, is also crushed under hot rollers, mixed with sugar and flavouring materials, and formed into a paste, called **chocolate**. Or the ground cocoa is mixed with sugar, starch, or other ingredients, and sold as soluble cocoa, rock cocoa and flake cocoa being produced in a similar way. In the inferior cocoas there is some of the husk, ground down as finely as possible and added to the ground bean.

The composition of cocoa shows some very important differences from that of tea and coffee.

Water	6·0
Theobromin	1·5
Fat (Cocoa Butter)	50·0
Starch	10·0
Albuminous	18·0
Gum	8·0
Colouring Matter	2·6
Fibre, &c.	0·3
Saline	3·6

Of the above constituents the most notable are the theobromin and fat. The former has been already noticed, in considering thein, &c. (p. 654). There is no statement of aromatic oil or tannin, the quantities of these substances being excessively minute. The remarkable feature is the large quantity of fat, cocoa-butter, or oil of theobromin. It is about the consistency of tallow, yellowish-white, with the marked odour of chocolate, and a pleasant taste. It keeps for any length of time, when pure, always retaining its agreeable odour, and on this account it is used by druggists as a basis for suppositories.

Value of Cocoa.—The fat, as well as the albuminous, gummy and starchy constituents, make cocoa highly valuable as a food-stuff. For it is to be remembered that the preparation of cocoa for use is of a different kind from tea or coffee. If an infusion only were used, as is the case with the latter, these constituents would be of as little importance as the albuminoids of tea and coffee. But it is not an infusion that is employed, but a simple mixture with water, so that the whole of the ground cocoa is introduced into the body. This is a point of very great importance. When it is duly considered it is evident that cocoa possesses a very high value as a food-stuff. Reference to the table shows that no less than 86 per cent is of value for the repair of tissue or the liberation of energy, the high value of fat for the latter being borne in mind. About 14 ounces of each pound consists of useful material. It is indeed a food rather than a beverage; but, at the same time, the theobromin and minute quantity of aromatic oil give it qualities of a stimulating, fatigue-removing, and invigorating character, similar in character to, though not so pronounced in amount as, those of tea and coffee. It is to be noticed, however, that the nibs are used in a way to produce rather an infusion with properties like tea or coffee. They are gently boiled in water for a couple of hours, the liquid portion is then poured off, and the undissolved parts of the nibs thrown out. This method of preparation dissolves only part of the seed, and the beverage produced falls far short, in nutritive qualities, of the material made by mixing the cocoa ground to a fine powder with boiling water.

There is now in the market a very large number of prepared ground cocoas, of exceedingly delicate flavour and of great nutritive value—Van Houten's, Tulloch's Pure Dutch Cocoa, Fry's Pure Cocoa, and so on. It would be the greatest possible benefit to many if they would substitute cocoa for tea or coffee at least once a day.

The quantity of fat present in cocoa makes it feel rather heavy and somewhat difficult of digestion to many. Hence the manufacturers of prepared cocoa endeavour to reduce the quantity of fat, either simply by abstracting some of it and leaving the cocoa otherwise unaltered, which is the preferable way, or by diluting the cocoa with sugar, or starch, or other similar substance, various kinds of sugar and starches being employed for the purpose. In some of the cocoas in the market it is said there is not more than 30 per cent of pure cocoa, the rest being additions of sugar, starch, &c., with colouring matter. Such additions are, properly speaking, adulterations. To such prepared or diluted cocoas, where the dilution is acknowledged and its extent duly stated on the label, there is no serious objection, but they ought not to be sold under the name of pure cocoa, homeopathic cocoa, dietetic cocoa, or the like.

The adulteration of cocoa with arrow-root, potato starch, and other starches, can readily be detected by means of the microscope (see p. 598).

It may be remarked that if cocoa is diluted with sugar simply, the cocoa needs only the addition of boiling water; but if it has been diluted with starch, the simple addition of boiling water will not properly cook the starch, will not render it soluble, and such cocoa would be rendered more digestible by boiling for a few minutes.

The saline matters of cocoa consist chiefly of potash salts and phosphates.

Brazilian Cocoa, or **Guarana,** is derived from the seeds of a small climbing plant (*Paullinia sorbilis*) growing in Brazil, belonging to the natural order *Sapindaceæ*, or soap-worts. The seeds are dried, then roasted, powdered, and made into a stiff paste with water, being mixed with some of the whole and broken seeds, and pressed into cylindrical masses, not unlike sausages, and called **guarana-bread.** Pieces are broken from the rolls and infused in hot water, like tea or coffee, to form a beverage, which is sweetened, and is said to be as grateful and refreshing as either of the latter. The active principle of gaurana is called *guaranine,* but is identical with thein, and exists to the extent of five per cent in the guarana rolls, which also contain tannin, gum, &c. In short, the beverage presents marked resemblances in its active constituents and in its effects to both tea and coffee, being used as a nerve stimulant and restorative. Powdered guarana, as well as the active principle, are used in medicine as a nerve tonic, and the former, because of its astringent property, is employed for diarrhœa and dysentery. Powdered guarana in 30-grain doses is most valuable for sick headache (see p. 113). It is extensively used in Brazil, Costa Rica, and other parts of South America.

Coca, or **Cuca,** is not to be confounded with cocoa. Coca leaves are derived from a shrub found growing on the mountains of Bolivia and Peru, called *Erythroxylon coca.* The leaves are used very extensively by the natives, and in South America it is said the annual consumption of leaves cannot fall short of 100,000,000 pounds. The late Sir Robert Christison, of Edinburgh, was the first in this country to investigate the action of the drug, and the following gives some interesting detail of his experiments on himself:—“In the beginning of May, under a day temperature of 58°, I walked fifteen miles in four stages, with intervals of half an hour, at four-mile pace, without food or drink, after breakfast at half-past eight, and ending with a stage of six miles at half-past five in the afternoon. I had great difficulty in maintaining my pace through weariness towards the close, and was as effectually tired out as I remember ever to have been in my life, even after thirty miles at a stretch, forty or fifty years before. . . . The pulse, naturally 62 at rest, was 110 on my arrival at home, and two hours later it was still 90. I was unfit for mental work in the evening, but slept soundly all night, and awoke next morning somewhat wearied and disinclined for active exercise, although otherwise quite well. Two days afterwards I repeated this experiment, and obtained precisely the same results. . . . Four days later, with precisely the same dietary, I walked sixteen miles in three stages of four, six, and six miles, with one interval of half an hour and a second of an hour and a half. During the last forty-five minutes of the second rest I chewed thoroughly eighty grains of my best specimen of cuca, reserving forty grains more for use during the last stage. To make assurance doubly sure, I swallowed the exhausted fibre, which was my only difficulty. On completing the previous ten miles, I was fagged enough to look forward to the remaining six miles with considerable reluctance. I did not observe any sensible effect from the cuca till I got out of doors and put on my usual pace, when at once I was surprised to find that all sense of weariness had entirely fled, and that I could proceed not only with ease, but even with elasticity. I got over the six miles in an hour and a half without difficulty, found it easy when done to get up a four-and-a-half-mile pace, and to ascend quickly two steps at a time to my dressing-room, two floors up stairs; in short, had no sense of fatigue or other uneasiness whatsoever. On arrival at home the pulse was 90, and in two hours had fallen to 72. . . . Before dinner I felt neither hunger nor thirst, after complete abstinence from food and drink of every kind for nine hours; but on dinner appearing in half an hour, ample justice was done to it. Throughout the evening I was alert, and free from all drowsiness. Two hours of restlessness on going to bed I ascribed to the dose of two drachms being rather large; and after that I slept soundly, and awoke in the morning quite refreshed and free from all sense of fatigue and from all other uneasiness.”

It is right to say, however, that every experimenter has not obtained such satisfactory results as Sir Robert Christison, though there is some reason for believing that failure is due to fresh leaves not being used, as there seems no doubt coca spoils with keeping.

Coca appears then to act somewhat like tea and coffee, stimulating the nervous system and lessening fatigue, for which purpose it is used by the Indians in Peru on long marches.

Coca yields an alkaloid, *cocaine,* which has the remarkable property of abolishing the sensibility of the skin and mucous membrane. Thus when a solution is applied to the tongue or throat, sensation is abolished in a few minutes, taste being in abeyance for some time. A couple of drops instilled into the eye will in a few minutes destroy sensation there, so that an operation may be conducted without pain. Sensation returns again after the lapse of some hours.

Kola-nut is the fruit of a tree, *Sterculia acuminata*, indigenous to Central Africa. The roasted nut is used to yield an infusion, employed by the inhabitants of Central Africa much as tea and coffee are. It contains fully 2·3 per cent of caffein, also 0·023 per cent of theobromin, and fully 1·6 per cent of tannin. An extract called *kolatina*, to be used like cocoa, is now to be had, and is said to be a stimulating beverage, having no bad effects upon the digestion.

ALCOHOLIC DRINKS.

Alcoholic drinks embrace a great variety of beverages, ardent spirits, wines, malt liquors, and so on. These all possess in common the one great feature of containing in greater or smaller quantity the spirit of wine or alcohol; and it will be well if we first of all consider what alcohol is, how it is obtained, and what are its effects upon the body. This will afford a basis for considering the characters and effects of the various liquors in which it forms an ingredient.

Alcohols.

Composition of Alcohol.—Alcohol is a word derived from Arabic, and implies anything very subtle. It was a term originally applied only to the spirit distilled from wine, and meant simply the spirit of wine. Chemists investigated its chemical character, and found it to be a definite compound of carbon hydrogen and oxygen, in certain proportions, namely, two combining weights of carbon, six of hydrogen, and one of oxygen; and thus alcohol was represented by the chemical formula C_2H_6O, expressive of the elements entering into the composition of alcohol, and the proportions in which they combined. It was then found that there was a series of substances, related to this spirit of wine from a chemical point of view, formed of the same elements in other proportions, and this series of substances came to be classed together as alcohols. The most commonly known of these substances are:—

Methylic alcohol or wood spirit or wood naphtha (CH_4O).
Ethylic alcohol or spirit of wine (C_2H_6O).
Amylic alcohol or potato spirit or fousel-oil ($C_5H_{12}O$).

Methylic alcohol is obtained by the destructive distillation of wood. Methylated spirit is ordinary alcohol, spirit of wine, to which this wood spirit is added, to prevent it being used for drinking purposes, and thus permit it being used for commercial purposes at a cheap rate. Amylic alcohol or potato spirit is usually produced in the processes of fermentation by which ordinary alcohol is obtained. It is the presence of this potato spirit in whisky which gives its peaty smell and burning taste. There is a large number of other alcohols, propylic, butylic, caproic, caprylic alcohols, and so on, many of which are produced in the fermentation of sugar along with ordinary alcohol, giving peculiar characters to the fermented liquor. It is, however, with ethylic alcohol, or spirit of wine, which is the one commonly meant when one speaks of alcohol, it is with it we have to do.

Preparation of Alcohol.—The ordinary alcohol with which everyone is familiar is produced in solutions containing sugar by a process of fermentation. This process is due to the activity in the solution of a little organism, the yeast plant. It is a single cell (Fig. 267), round or oval, measuring in its greatest diameter on an average about $\frac{1}{3000}$th of an inch, some larger and some smaller. Each little cell is an independent organism, capable of living and, unaided, reproducing its kind. This latter it accomplishes by budding. A minute prominence appears at some part of the surface of the cell, enlarges, and finally attains a size nearly equal to that of the mother cell. The connection between the two becomes narrowed, and finally the young cell separates and becomes an independent organism, speedily throwing off buds itself. The cells thus multiply in a suitable medium with enormous rapidity. Let any one who owns a microscope take a minute speck of brewer's yeast on a glass slide, place on it a drop of water, mix the two, cover with a cover-glass, and examine under a lens magnifying by 300 diameters, and he will see hundreds of such bodies as are depicted in Fig. 267. Now when such yeast is sown in a sugary solution, let us say in the juice expressed from ripe grapes, it proceeds to multiply with great rapidity. It does so at the expense of the

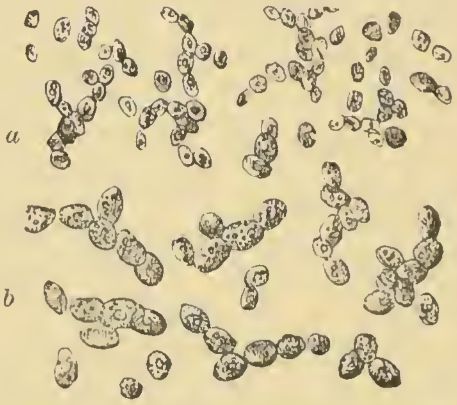

Fig. 267.—Yeast Cells (ferment) growing during forty-eight hours: (*a*) magnified 200, and (*b*) 400 diameters. After Beale.

solution, and as an absolutely necessary part of its vital operations, it produces chemical changes in the sugary solution. The sugar, which consists of carbon, hydrogen, and oxygen, is split up into two different substances, part of the carbon going with part of the oxygen to form carbonic acid gas (CO_2), and the remainder of the carbon going with hydrogen and oxygen to form alcohol (C_2H_6O). Sugar disappears, that is to say, and alcohol and carbonic acid gas take its place, produced from it by the activity of the yeast plant. Thus it is that if anyone sows yeast in a sugary solution and keeps it at a moderate temperature, minute bubbles of gas will be seen rising in great numbers, bubbles of the carbonic acid gas escaping, and alcohol will have been produced in the solution. Very many most elaborate researches have been made by the most distinguished chemists, such as Lavoisier, Gay-Lussac, Thénard, De Saussure, and Pasteur, to determine whether the quantity of carbon, hydrogen, and oxygen in the sugar which disappeared could be accounted for in the quantity of alcohol and carbonic acid gas produced, with the result of obtaining almost exact correspondence. Thus 105·26 parts of grape-sugar (equal to 100 parts of cane-sugar) have been found to yield:—

Alcohol	51·11 parts.
Carbonic Acid Gas	48·89 ,,

which, along with 5·26 parts of other substances formed in course of the fermentation, such as glycerine, succinic acid, and a small proportion united with the yeast, make up the 105·26 parts of grape-sugar.

Alcohol then is produced by the agency of a living organism from the decomposition of sugar. One pound of sugar yields rather over ½ lb. of proof spirit, or over ¼ lb. absolute alcohol. It is only, however, from sugars capable of fermentation that alcohol is produced *directly*. Such sugars are grape-sugar, in particular, found in many vegetable juices, muscle-sugar or inosite and other similar sugars, already noted on p. 587. Cane-sugar, beetroot-sugar, and milk-sugar are not capable of immediate fermentation, but can be converted into grape-sugar by various means and then made to yield spirit. Moreover, we have seen that starch is capable of conversion into sugar by the agency of various ferments, and is so converted in the body by the action of saliva (p. 143) and pancreatic juice (p. 145) as a necessary part of the process of digestion. Further, we have noted that the starch so richly present in wheat may be converted into sugar by the action of a ferment, present in the wheat grain itself (p. 559), that the starch of the barley grain is also convertible into sugar by a ferment present in the barley, produced in the grain in the process of germination, and that it is only necessary to place the grain in circumstances of heat and moisture for that process of conversion to proceed. Hence it follows that when such conversion is achieved it is only needful further to add some yeast, to set agoing the second process by which alcohol will be produced. Starch may be converted into sugar by chemical means, by boiling with sulphuric acid, and it is grape-sugar that is thus formed. It is evident, therefore, that any substance whatever which contains either sugar or starch can by the appropriate means be made to yield alcohol. So not only fruits like grapes, and vegetables like turnips and potatoes, but an infinite variety of incongruous substances, old paper, dusty legal parchments, raw cotton and flax, rags, and even sawdust can be made to yield alcohol. The quantity of starch or sugar in these latter substances is, however, too small to permit of alcohol being manufactured from them except at great cost. Hence in the production of alcohol the cereals which contain starch in large quantity, barley, &c., are commonly used. Potatoes, also rich in starch, are largely used on the continent of Europe to yield an inferior spirit—potato brandy. 100 lbs. of corn yield nearly 3½ gallons proof spirit, and one bushel of malted barley produces, on an average, 2 gallons of spirit; while 100 lbs. of starch yields 70 lbs. sugar, and that yields 8 gallons proof spirit.

Though it was known in very early times that vegetable juices like that of the grape, if allowed to ferment, underwent some change by which an intoxicating character was produced, the real substance—the spirit—to which this was due was not known by itself, and was not separated from the wine till the twelfth century, when Abucasis, by a process of distillation, was able to separate it. Hence the name, spirit of wine, given to it.

The method of producing whisky will illustrate the various processes in the preparation of alcohol. For the manufacture of whisky barley is employed. It contains (p. 558) fully 65½ per cent of starch. The whisky manufacturer has therefore three processes to conduct: (1) he must get the starch converted into grape-sugar, and obtain this in solution, (2) he must excite in the sugary solution the alcoholic fermentation, and cause it to be maintained till all the sugar is converted into alcohol and carbonic acid gas, (3) he must then separate out the produced spirit. The first process is called **malting the grain**, and the solution obtained is called the **wort**, the second process is the **fermentation of the wort**, and the third process is that of **distillation**. The barley is first steeped in water till the grains are well swollen. After being drained it is spread out on the floors of the malt-house, when germination begins and much heat is developed. The germination is allowed to proceed till the germ (acrospire) is about to burst the seed coat, which occurs in from fourteen to twenty-one days. At this stage further sprouting is stopped by the grain being dried in a kiln. The changed grain is now called malt, and is of a pale, amber, or dark colour according to the heat applied in drying. Malt differs from barley in containing a small proportion of sugar, and specially in containing a ferment, called **diastase**, which did not previously exist in the barley grain, but is produced in the course of germination. Now this diastase possesses the property of converting starch into grape-sugar with great rapidity. Accordingly the next business of the whisky manufacturer is to place the malt in such circumstances that the diastase will have free opportunity of performing its task. Accordingly the malt is bruised and placed in a large vessel called a mash-tun, water at a temperature of from 157° to 160° Fahr. being mixed with it. The water dissolves the sugar already present in the malt, as well as the diastase, which thus gets ready access to the starch of the malt, and the conversion into sugar proceeds with great rapidity. In a few hours it will be complete. So active is diastase that 1 part can convert 200,000 of starch. "Thus 100 parts of starch made into a paste with 39 times its weight of water, and mixed with 6·13 parts of diastase in 40 parts of water, produced 86·9 parts of sugar in one hour" (Smith). The activity of the ferment is so great that it is capable of converting a much larger quantity of starch into sugar than is actually present in the grain. On this account it is common to add to the mash-tun unmalted grain, or starch derived from other sources such as potatoes. By this means the trouble of malting a considerable amount of grain is saved, as well as an actual loss of substance; for in the malting process there is a loss of solid matter of the barley to the extent of thirteen per cent. Whisky thus produced has, however, a harsher and less agreeable flavour than that entirely obtained from malted grain, and is an inferior article. When the starch has all been converted into sugar, the sweet wort, as the infusion is called, is boiled to destroy the diastase. The boiled liquor is then run off, cooled, and transferred to the fermenting tun, where yeast is added, and allowed to act till all the sugar has been split up into alcohol and carbonic acid gas. In the final process the fermented liquor is placed in a vessel called a still, set over a fire. From the dome-shaped cover of the still passes a tube, which proceeds in a spiral fashion, and is hence called a worm, through a vessel which contains cold water. The heat raises the alcohol as vapour, and in passing through the worm, it is condensed and caught in the receiver. The alcohol passes over along with a considerable quantity of watery vapour, and pure alcohol is not immediately obtained. What is obtained by the first distillation may be again distilled, and again and again, but even when repeatedly redistilled, the spirit still contains about 9 per cent of water, which can only be got rid off by other means. Moreover, not only water passes over with the alcohol, but also the vapour of other substances produced in the wort. The nature of these other substances depends upon the source of the spirit, grape-juice, barley, rye, &c., and it is their presence which gives to the spirit its peculiar character and flavour. Thus acetic acid and fousel-oil are usually present in small quantities.

Rectified Spirit is spirit from which all impurities, such as fousel-oil and acetic acid, have been removed by redistillation and other means. But, as already said, the most highly rectified spirit still contains 9 per cent of water.

Absolute Alcohol is the term applied to perfectly pure alcohol, from which all the water as well as other impurities have been removed. It is transparent and quite colourless; "has an enlivening odour and a burning taste." It is lighter than water. At a temperature of 68° Fahr., a vessel which will hold 1000 grains of water will, if filled with absolute alcohol, weigh 208 grains less, that is its specific gravity is only 792, that of water being taken as 1000.

Proof Spirit is the proportion of spirit and water allowed by act of parliament for excise purposes. It is said to consist of:—

Alcohol (by weight)	49·24
Water (by weight)	50·76

in 100 parts (by weight) of proof spirit. Spirits weaker than this are said to be under proof, and stronger than this are said to be over proof.

Fifty over proof means that the strength of the spirit is such that to every 100 parts of the spirit 50 parts of water would require to be added to reduce the strength to proof; or if the spirits be 20 over proof, 20 parts of water need to be added to every 100 parts of the spirits to bring them down to proof. On the other hand 30 under proof would mean that every 100 parts of the spirits contained only 70 parts proof spirit and 30 of water.

Proportion of alcohol in various spirits, wines, &c.—The proportion of pure alcohol by volume in the various spirits, wines, &c. in common use is shown in the following table:—

Brandy	55·39	per cent.
Whisky (Scotch)	54·32	,,
Whisky (Irish)	53·20	,,
Rum	53·68	,,
Gin	51·60	,,
Port Wine	20·25	,,
Sherry Wine	16·30	,,
Madeira Wine	16·10	,,
Claret and Hock	8 to 13	,,
Champagne	7 to 12	,,
Edinburgh Ale	5 to 6	,,
Porter	5 to 7	,,
Lager Beer	5·1	,,
Cider (average)	6·0	,,
Gooseberry Wine	3·0	,,
Ginger Wine	1 to 6	,,

Brandy is prepared by distilling wine, or at least ought to be so prepared; 1000 gallons of wine yield from 100 to 150 gallons of brandy, containing from 50 to 54 per cent of absolute alcohol. Its quality varies with the wine from which it is prepared. The most delicate is yielded by white wine, and the white wines of the Cognac and Armagnac districts of France are specially prized for the purpose. Inferior wines are used to obtain cheaper qualities of brandy; poor qualities are produced from the refuse of grapes, wine-presses and wine casks, being made up with other substances. Much alcohol sold as brandy is simply spirit obtained by the fermentation of sugar, as in the preparation of whisky, coloured with burnt sugar and flavoured. Thus the fiery spirit produced in Germany from potato starch is, after redistillation in France and colouring, sent over to Britain as brandy. Brandy when produced is colourless, and obtains its dark hue from keeping in oak casks. "The brandy made in England is for the most part artificial. A very usual process is to add to every 100 parts of proof spirit from half a pound to a pound of argol [the tartar from the inside of wine casks] some bruised French plums, and a quart of good Cognac; the mixture is then distilled, and a little acetic ether, tannin and burnt sugar added afterwards" (Blyth).

The peculiar flavour of brandy is derived from the wine from which it is distilled, and depends on various volatile oils and œnanthic ethers, which pass over with the spirit in course of distillation. Some of these are also produced by slow chemical changes of the nature of oxidation, changes which go on in the brandy if it is kept long, and which also vary with the original quality of the spirit. Thus brandy contains besides alcohol and water, acetic, œnanthic, butyric, and valerianic ethers, small quantities of grape-sugar, minute quantities of a volatile oil, colouring matter, a trace of tannin, acetic acid, and a little fixed acid. Old brandy is characterized by the presence of these various ethers, to which the special flavour is due.

Whisky.—Whisky is prepared from malted barley, or often a mixture of malted barley and raw grain as is common in Ireland. It also contains various volatile oils which pass over in distillation. It also is improved by age, harshness and fieriness being mellowed thereby. The peaty flavour is said to be due to the peat or turf fires over which the malt is dried. But one ingredient, almost commonly present, confers a peaty taste, namely fousel-oil or potato spirit. A small quantity is produced in course of manufacture, but it is sometimes added as an adulteration, being cheaply prepared. It is this which gives the fiery taste to crude spirits; and it is an injurious ingredient, producing headache and giddiness, from which men engaged in the production of potato spirit suffer, unless some arrangement exists for preventing inhalation of the fumes. Whisky is by preference kept in sherry casks to acquire colour and flavour. Whisky also contains some acetic acid, but should contain no sugar.

Rum is the spirit distilled from molasses which have been allowed to ferment. It is coloured with caramel. It is a West Indian product, where molasses, skimmings from sugar-boilers, &c. are mixed with water and distilled after fermentation. Poor qualities are prepared from the waste of sugar-cane. In France it is also manufactured from the skimmings, &c. of the beet-sugar factories. The finest qualities are rich in volatile and essential oils, and by keeping it acquires a very soft mellow flavour. It may also contain a small quantity of sugar and acid. To every 6 cwt. of sugar produced on a plantation there is usually also 1 gallon of rum.

Rum which, by age, has lost in alcoholic strength and gained in flavour by the development of œnanthic ether is, according to Dr. Ed. Smith, the purest and most healthful member of the spirit class, and the most perfect cordial with which we are acquainted.

Gin is entirely a prepared spirit, made up usually of an inferior alcohol, distilled from barley malt and unmalted rye, and apt to contain a considerable proportion of fousel-oil, and flavoured by means of various substances, specially juniper berries, coriander seeds, orris root, angelica root, grains of paradise, cardamom seeds, cassia buds, turpentine, creasote, &c. The name gin is derived from Genièvre, French for the juniper, and this supplied the term Geneva by which it is sometimes called, which became corrupted to gin. It was at first imported from Holland only, and thus went under the name "hollands." "Cordial gin," or "Old Tom," is the same article sweetened. The juniper berries give it diuretic properties, that is cause it to act upon the kidneys, so as to increase the quantity of water passed. After the spirit has been distilled over from the fermented grain, it is submitted to a redistillation for the purpose of rectifying it. It is at this stage the juniper berries and other materials are added, the redistillation then proceeding. Each distiller usually has a mixture of flavouring ingredients of his own liking.

Arrack is the distilled spirit of the fermented juice of the cocoa-nut tree, and is obtained also from palm-wine (see p. 581). It is also distilled from fermented rice liquor. It contains usually 52·7 per cent of alcohol, and it is largely consumed by the Hindoos and Malays.

Liqueurs or **Cordials** are strong spirits, usually highly sweetened, and flavoured by various fruity or aromatic substances. They are also commonly brightly coloured by means of cochineal, turmeric, &c. They are used to stimulate digestion, and are taken in small quantities at the end of dinner.

Absinthe is flavoured with the oil of wormwood (*Artemisia Absinthium*), and with peppermint, angelica, cloves, cinnamon, and aniseed. It is coloured green by vegetable juices. It contains 50 per cent of alcohol, and 1½ of sugar. The oil of wormwood is present to the extent of ⅓rd per cent. The oil of wormwood has a poisonous action on the nervous system, and absinthe is said to be "one of the most treacherous and pernicious for habitual use of all the liquids of the alcoholic class" (Pavy).

Curaçoa is a liquor containing 47 per cent alcohol, 28½ per cent cane-sugar, and is flavoured with orange peel.

Benedictine has 44 per cent alcohol and 32½ of cane-sugar.

Noyeau is flavoured with the kernels of peach, apricot, bitter almonds or cherry. It is cherries which flavour **Maraschino** and **Kirschwasser**. The latter is distilled from the fermented juice of bruised cherries, in which the kernels of the stones have been kept. **Chartreuse** has a flavouring of angelica oil and a peculiar kind of turpentine.

The Effects of Alcohol on the Body and Its Value.—Is Alcohol a Food? On the answer to this question largely depends the estimate one will form of the value of alcoholic drinks to the body. What the meaning of that question is, no one, who has read the early pages of this section with any understanding, ought to have any difficulty in apprehending. Does it yield up anything to the body for the repair of tear and wear of tissue? or does it undergo combustion in the body to yield energy for heat and work? These are the two parts of the same question. It consists of carbon hydrogen and oxygen only, and the absence of nitrogen at once settles the question of its power to aid directly in the repair of wasted tissue, but its carbon and hydrogen are capable of combustion. From such chemical considerations Liebig came to the conclusion that it was a respiratory food, that its carbon and hydrogen underwent combustion to carbonic acid gas and water, yielding energy for heat. "Of all respiratory matters," he says, "alcohol acts most rapidly." . . . "Alcohol stands high as a respiratory material. Its use enables us to dispense with the starch and sugar of our food, and is irreconcilable with that of fat." Later than this, researches undertaken by certain French investigators, Lallemand, Duroy, and Perrin, went to show that Liebig had been mistaken. Their experiments seemed to show that alcohol, taken into the body, passed through it *unchanged;* and their conclusions were based upon the fact that shortly after alcohol had been taken, it could be detected escaping by the breath, the urine, and the skin; and could be so detected for many hours. They therefore concluded that it was all given off from the body as alcohol. If this were so, it is obvious it could not be considered a food, for it could not undergo oxidation for the liberation of energy for either heat or work. They therefore stated that it was not in any sense a food. These results were confirmed by Dr. Edward Smith, who detected alcohol in the breath four hours after 1½ oz. had been taken. It was shown, however, by Dr. Anstie (1864), and in the preceding year by M. Baudot, that although it was quite true that alcohol can be detected as such in the breath, sweat, and urine for many hours after alcohol has been taken in any quantity, yet the quantity so cast off from the body is only a very small fraction of what has been consumed. Dr. Anstie showed that the tests employed were extremely delicate, and would indicate the presence of alcohol, even though only a very minute quantity escaped from the body unaltered. These results were corroborated in 1872 by Dr. A. Dupré, who found that only a minute fraction of the amount of alcohol taken was cast off as such in the breath, sweat, &c., and that the greater portion was retained and destroyed in the body. What changes it undergoes is not known, but it is thought to be a reasonable conclusion that it undergoes oxidation, and sooner or later is used for the liberation of energy as work or heat. Dr. Parkes, however, inclines to the view that it becomes changed simply to acetic acid, and that it might subsequently unite with the soda of the blood, finally being expelled in the urine in the form of a carbonate. "If this view is correct," he says, "the use of alcohol in nutrition would be limited to the effects it produces, first as alcohol, and subsequently as acetic acid, when it neutralizes soda, and is then changed into carbonate."

On the whole the present generally accepted view is that alcohol does take rank as a food, undergoing changes in the body leading to the liberation of energy. There is also some more or less valuable evidence that alcohol can replace food to some extent, that if the food is insufficient for the bodily wants, the addition of a small quantity of alcohol will remedy the deficiency. Thus Dr. Anstie relates a number of very remarkable cases, not of persons suffering from disease only, but also of persons otherwise healthy, who regularly took an amount of food utterly insufficient for bodily purposes, and along with it a considerable supply of alcohol, and who did not exhibit any of the signs of emaciation and prostration that would be expected, in whom, that is to say, alcohol took the place of food. These cases, however, are so remarkable that Dr. Anstie hardly offers sufficient proof of their entire credibility. Dr. Hammond, however, an American physiologist, made a direct experiment of this kind upon himself. He took for sometime an insufficient diet, and found he was daily losing weight upon it. He then added to it only a small proportion of alcohol and, thereupon, found that he not only ceased to lose weight, but actually converted the loss into a gain. For such reasons the conclusion indicated has been arrived at, that alcohol is able to a certain extent to take the place of a certain amount of the necessary daily quantity of food.

There is another way in which it appears alcohol may affect the nutrition of the body. It appears certain that alcohol diminishes oxidation changes going on in the body. It diminishes combustion, the consumption of material going on in the body. This is effected by lessening the rate at which the blood gives up oxygen to the tissues, and as oxidation cannot go on in the body without the proper supply of oxygen any more than a fire can burn without a proper supply of air (see p. 527), so this lessening of the amount of oxygen to the tissues diminishes the tissue waste. Such a diminution of combustion is not a desirable thing in a state of health. It implies an interference with the natural processes of the bodily economy, and a lessened liberation of energy for work. It may be, and very often is, a most desirable result to obtain in a state of disease; but it is scarcely correct to call alcohol a food because of this effect. It is, on this account, rather a drug, such as quinine which exerts a similar influence. It is probable that the fattening effect of alcohol, the tendency to an unhealthy deposition of fat in persons who drink considerable quantities of alcoholic liquors, is due to this result of diminished oxidation. In particular this is noticeable in those who drink largely of malt liquors, in which there is present sugar to a greater or less extent. The consumption of this, as well as of sugars and fats in the food, being prevented, it is converted into fat and deposited. Moreover it is a well-known tendency of alcohol, when used to excess, to produce fatty degeneration of various organs of the body.

Setting aside, however, this fact of the diminished oxidation due to alcohol, as being, on the whole, prejudicial in a state of health, however useful in disease, and as not justifying the description of alcohol as a food, and accepting the view that it can besides undergo combustion in the body to yield energy, and, on this account, to be rightly reckoned to some extent as a food-stuff, the question that next arises is to what extent does alcohol become useful, in a state of health, in virtue of its latter property? Supposing it to be admitted to the class of energy-yielding foods, may it be employed to any extent as such? Supposing enough of albuminous foods, such as beef, eggs, fish, &c., be given to supply waste of tissue, could alcohol be given in sufficient quantity to yield the needed energy for heat and work? This raises the question, What other effects does spirit of wine produce on the body which may limit or impair its use as a food? In the following paragraphs an answer to this very wide question will be attempted, in the light of the most recent researches on the subject.

The Effects of Alcohol on the Body.—In general alcohol produces two kinds of effects, apparently very different from one another, dependent upon the quantity taken. In small doses it is a general stimulant, in large doses it is a narcotic poison. Here, at once, we are face to face with the broad fact that if alcohol is entitled to be classed as an energy-yielding food, its usefulness as such is strictly limited. Abundant illustration might be given of these two kinds of action. To an old person with enfeebled digestion a small quantity of brandy and water or whisky and water, given with food, enables the meal to be digested more easily. This is probably because the *slight* irritant effect upon the stomach, akin to the glow experienced in the mouth with the contact of the spirit and water, brings a larger supply of blood to the lining membrane and an increased flow of gastric juice from the stomach glands for digestive purposes. But if the dose is excessive, the irritation becomes so great that stimulation passes into paralysis, the quantity of digestive fluid becomes diminished, thick, and inactive, and perhaps is arrested, and patches of congestion appear on the stomach wall. These effects Dr. Beaumont saw with his eyes produced in the stomach of St. Martin (p. 601), after excess. The result was arrested digestion, wholly or partially. When these effects are marked, instead of the keener relish for food and increased appetite following the use of the small quantity, there are the loathing for food or simply the loss of appetite, the uneasy sensations about the stomach, the parched mouth, sickness, vomiting, and so on, so well known to too many. But the noticeable feature is that Dr. Beaumont observed the paralysing effect upon the stomach before St. Martin had any sensations, intimating to him any interference with digestion.

The stimulating effect of small doses and the depressing and paralysing effect of large doses of alcohol are also produced on the heart and circulation. With small doses the heart beats more quickly and strongly, and the flow of blood is thereby quickened through the body, to the brain, the muscles, and the skin. Moreover, the blood-vessels dilate, and the blood flows more readily through them. Thus the face flushes, the arteries of the temple throb, the skin, pinched and wrinkled and blue with cold, becomes softer, fuller, and ruddier, and a feeling of glowing warmth takes the place of the miserable shrivelled feeling the cold had induced. This is the stimulating action on the heart and circulation. But a large dose produces enfeebled and irregular action of the heart, and it has been shown that both in animals and man a large dose of alcohol may kill immediately by sudden stoppage of the heart's action. This, however, is due to the shock produced by the entrance of the large quantity into the stomach, by reflex action (p. 86), that is to say on the heart, and not by the spirit acting on the heart through the blood, though after the lapse of a little time a large dose would produce a like effect, acting through the blood.

In the same way a stimulating or a paralysing action is produced on the brain and nervous system in general, according to the quantity of spirit consumed. The lively imagination, the rapid flow of ideas, the sharpened wit, the freer discourse, the more generous enthusiasm, or it may be the more combative and argumentative spirit, are some of the stimulating effects of alcohol upon the nervous system, partly due to the increased supply of blood, owing to the quickened circulation, but also due to the direct action of the alcohol, circulating in the blood, on the nerve-centres. But the more markedly this stimulating effect is produced, the more near is one to the commencing of the paralytic action, when the loss of self-restraint indicates that the higher centres are beginning to succumb. The unsteady gait or speech proclaims the loss of the power properly to co-ordinate muscular movements for definite purposes, and rambling remarks, confused and stupid appearance, tell that the higher faculties of the brain are under the paralysing influence of the alcohol. It is the higher nerve-centres, those of the brain, that first experience the narcotic effect; the nerve-centres of the spinal cord are all affected later. Thus a man who cannot keep his feet may yet keep his saddle, if he is accustomed to ride, because it is the lesser brain or cerebellum (p. 93) that regulates the combined muscular movements necessary for walking, and that function is largely in abeyance, while he keeps the saddle owing to a reflex action (p. 86), the stimulus derived from the thighs in contact with the horse acting on the nerve-centres of the spinal cord, which the alcohol has not yet overpowered. Even when the narcotic action on the nervous system is so pronounced that the man lies "dead drunk," insensible to kicks or blows, every muscle relaxed and powerless, one part of the nervous system may yet remain less powerfully affected, the medulla oblongata (p. 93), in which are the nerve-centres maintaining the action of the heart and the movements of breathing. It is not unless the dose has been sufficient to abolish their action also that death results, and it is usually the cessation of breathing that determines death, the heart continuing to beat a brief time longer.

Well then, it may be said, alcohol is safe so long as one does not exceed the quantity that simply stimulates. This might be admitted if it were possible to mark the point where stimulation ceased and narcotic action began. It is not easy to determine such a point, because one follows so hard on the track of the other. The depressing action, indeed, is the direct consequence of a certain degree of stimulation; it is exhaustion produced by the alcohol having goaded the organ, the nerve-centres, let us say, into expending more energy than it could speedily replace. In different individuals, too, the proportion between the two effects is very variable. In one individual the stimulating effect is hardly noticeable, it is so short-lived, and only the depression is prominent, even a small dose producing bad effects, while another seems to be unaffected except by large quantities. Indeed it is a question whether the stimulating effect is not in some senses actually already a paralysing one. The increased flow of blood to the stomach may be because the contact of the spirit with the stomach wall has partly paralysed the finer blood-vessels, has diminished, that is to say, the tone of their walls, so that they become more flaccid and more readily yield to the pressure of blood within them. The apparent stimulus to the heart may be because already a slight paralysing action is being exerted upon the restraining nerve of the heart (the pneumogastric, p. 96) and the exciting nerve of the heart (the sympathetic, p. 225) is not being properly and healthily restrained. It is certainly the view that the flushing of the face and the manifest more ready flow of blood to the skin are due to a certain degree of paralysis of the nerves (the vasomotor nerves, p. 233), which control the size of the blood-vessels, and so the pressure of blood easily dilates the vessels. Undoubtedly this is the explanation of the persistent redness of the face, nose, &c., of those who habitually indulge; the blood-vessels have lost their tone by the continued action of the spirit. If, again, the alcohol seems to stimulate the nervous system, one must not overlook the fact that, though ideas and speech become more rapid, control of them is less effective, and the healthy restraining influence of the higher nerve-centres is lessened. There is undoubtedly good reason for believing that the apparent stimulating action may be only a slight paralysing action in disguise, and, if so, it cannot be useful for a man *in health*, however useful it may frequently be in cases of disease. It has further to be noted that well-marked remote effects follow the habitual use of alcohol, not only in large doses but also in small, and apparently, harmless doses if frequently repeated. A man may take, for example, a nip of whisky or brandy without any apparent or actual effect, but if he is regularly in the habit, in connection with business transactions, for example, to have sundry and frequent nips a-day, though not one seems to have any effect upon him, yet in time slow changes are set up in various bodily organs, which become evident, it may be, only after years of continuance of the practice. These slow changes are of the nature of a degeneration, fatty or fibrous. The true structure of the organ or organs affected undergoes fatty degeneration, such as the muscular fibre of the heart, or becomes transformed into a fibrous character, such as is exceedingly common in the liver, giving rise to what is called "gin-drinkers'" liver, and also in the kidneys. The brain and nervous system may also be similarly affected. Now a man may become thus affected as a consequence of frequently-repeated small doses of spirits, who has never been known to be intoxicated, and whose friends are prepared to certify as a "strictly temperate man."

It will be well at this stage to note particularly what is the general tenor of the conclusions we have reached. They are these:—

1. *Alcohol is to some extent used up in the body, and may, therefore, liberate energy for heat or work, so that in a limited sense it may be classed as an energy-yielding food.*
2. *If alcohol is employed beyond certain small doses, it has injurious effects of a paralytic kind upon various organs of the body.*

Thus the first conclusion is qualified in a very important way by the second, for a food-stuff which, if used, except in small quantity, will have an injurious effect, is scarcely to be considered of value as a food-stuff at all, it is little more than a drug.

Supposing the remarks that have been made as to the difficulty of marking a line between one kind of effect of alcohol and another, the evidently poisonous effect—supposing these remarks to be accepted as indicating the impossibility of saying to anyone, "You may take a certain quantity of alcohol without fear of harm," the question may yet be asked is it not possible to lay down a limit beyond which injury is almost certain to arise? If one cannot say, "You are perfectly safe within a certain limit," it will be at least of some use if one can say, "You are certainly in danger beyond another limit." This both Dr. Anstie and Dr. Parkes and others have attempted to do. It has been said that alcohol appears in the urine, breath, and sweat, some time after a quantity has been consumed. An endeavour was made to find what quantity, if any, could be given to a healthy man in twenty-four hours, *without any appearing in the urine.* As soon as any began to appear in the urine, that was accepted as an indication that more had been introduced into the body than could be disposed of, and that the introduction of more could almost certainly be productive of no useful effect. Dr. Anstie found that when a quantity exceeding one ounce and a half of pure alcohol (absolute alcohol) was introduced, *not at one time, but in 24 hours,* the limit was passed. Dr. Parkes and Count Wollowicz corroborated this in a very remarkable way by finding that in strong healthy men, accustomed to alcohol in moderation, they observed the beginning of injurious effects when a quantity of spirit was introduced in 24 hours, which contained between one and one and a half ounces of absolute alcohol. "Assuming the correctness of these experimental data," says Parkes, "which, though not extensive, are yet apparently exact, it is evident that moderation must be *something below* the quantities mentioned; and, considering the dangers of taking excess of alcohol, it seems wisest to assume 1 to 1½ fluid ounces of absolute alcohol in twenty-four hours as the maximum amount which a healthy man should take." The meaning of absolute alcohol is explained on p. 666. It, of course, is not used at all as a drink, and one could consume varying quantities of the different alcoholic drinks, without exceeding the 1 ounce of absolute alcohol, according to the percentage of alcohol they contain. The quantities can be calculated from the table on p. 667, where the varying percentage is stated. If whisky contains, in round numbers, only 50 per cent absolute alcohol, obviously 2 ounces of whisky will yield 1 ounce of absolute alcohol. An ordinary wine-glass contains generally about 2½ ounces of whisky, that is half a gill, and that quantity is beyond the limit of safety. The following table shows the relative quantities of the different drinks:—

1 oz. absolute alcohol is contained in	2	ounces whisky;
1 ,, ,, ,, ,,	5	,, wines like sherry and port;
1 ,, ,, ,, ,,	10	,, ,, claret and hock;
1 ,, ,, ,, ,,	20	,, (1 pint) beer.

If a healthy man, then, take in 24 hours more than ⅘ths of a glass of whisky or brandy, 2 glasses port or sherry, 4 glasses (a half-pint) claret, or hock, or champagne, or a pint of beer, he takes a quantity which will produce effects on the bodily organs likely to be injurious, whether such effects are perceptible or not. For women the quantity is smaller, and any quantity to children in health is injurious.

The value of Alcohol to the Body.—Judged by the facts that have been briefly passed in review alcohol has no value for the *healthy* human body, *under ordinary circumstances. The taking of stimulants is, therefore, a question of individual taste and pleasure,* just as is the use of condiments, and as soon as the quantity taken for pleasure exceeds a certain small amount the region of possible danger is entered. Within the limit named, each person must be allowed to act according to his own judgment and inclination. There are, however, circumstances in which alcohol has, or is generally supposed to have, directly beneficial effects, circumstances which may be said to be more or less beyond the ordinary. What are these circumstances, and how far is the general idea concerning them correct is our next question?

It is a common idea that alcohol in some form is exceedingly useful when the body is subject to the pressure of great exertion. On this point there is now, fortunately, a great body of evidence, drawn chiefly from the experience of troops on the march and engaged in fighting. Dr. Parkes thus summarizes the results of his observations during the Ashanti campaign (1874). "The first effect of alcohol, when given in a moderate dose (for example, what is equal to one fluid ounce of absolute alcohol), is reviving, but this effect is transient. The reviving effect goes off after at the utmost two and a half miles of additional march, and sometimes much before this; then the previous languor and sense of exhaustion not only return, but are sometimes more intense, and if alcohol is again resorted to, its effects are now less satisfactory. Its reviving power is usually not so marked; and its peculiar anaesthetic and narcotizing influence can usually be distinctly traced. The men feel heavy, dull, disinclined to march, and are less willing and cheerful." In the Red River expedition, led by Sir Garnet Wolseley, spirit rations were not issued. "The men were allowed a large daily ration of tea, 1 oz. per man—practically as much as they could drink; and, as I am now on this subject of bohea *versus* grog, I may as well state that the experiment was most successful. The men of no previous expedition have ever been called upon to perform harder or more continuous labour for over four months. . . . This expedition would have been a bright era in our military annals had it no other result than that of proving the fallacy hitherto believed in of the necessity of providing our men when in the field with intoxicating liquors." Sir Garnet Wolseley recommends substituting tea for rum, which results in increasing the efficiency and health of the men. There is abundant and remarkable evidence to the same effect. It appears, then, that alcohol by its stimulating effect may enable one to put forth a great effort for a very brief period. But it supplies no energy for overcoming the difficulty; it compels an increased expenditure of energy without supplying the material from which the energy is to be obtained. As a result in a brief period its effect is over, leaving greater exhaustion than before. It lessens the power of sustained work. Its action in this way may be compared to putting the "blower" on a low fire, which occasions a more rapid entrance of air and a temporary quickening of the dying flame. It is like the prick of the spur in the side of the tired horse, "eliciting force without supplying it." If alcohol is useful in fatigue, it is not when the work is being done, but *after it is over*, if restorative food can also be had. Then it may be like the "blower" over a low fire, *which has received a new supply of coal.* It stimulates the exhausted body to appropriate the benefits of the food, though even under these circumstances its use is inadvisable if food and rest are sufficient for the purpose.

Alcohol has been supposed to be useful during prolonged exposure to cold. The error here is easily pointed out. By its stimulating effect upon the heart, and the dilatation of the smaller blood-vessels it produces, it causes a freer supply of blood to the skin, and a consequent glowing sensation of warmth. This, however, is delusive. The spirit supplies no added heat worth noting, and the greater quantity of blood flowing in the skin exposes the body to a much increased loss of heat. We have seen (p. 309) that the heat of the body is maintained in a cold external atmosphere by contraction of the vessels of the skin, and a lessened supply of blood to the surface. Alcohol produces the opposite effect, and thus the body parts with its heat at a greatly increased rate. Its use under these circumstances is dangerous. But when the exposure to cold is over, and the person is amid comfortable surroundings, then, if necessary, alcohol may be used, and quickly arouses a feeling of warmth by permitting the blood to flow to the skin.

The opposite condition to cold, great heat is, it appears, also less easily borne with the use of alcohol, which, according to Parkes, predisposes to sunstroke.

The value of alcohol when food is persistently deficient has been already alluded to. In ordinary circumstances one would say the food ought to be as readily procurable as the alcohol, and at a much cheaper rate. In cases of disease, however, when the difficulty of taking food cannot be overcome, alcohol does often become an agent of great value. But if the use of alcohol were restricted to disease, few would be found to object. This circumstance connected with alcohol has, however, a bearing which may be indicated in closing these considerations.

Hitherto the author has not sought to express any opinion as to the value of alcohol. His desire has been simply to marshal the chief facts which scientific investigation has revealed, whatever these facts might be. The only opinion he ventures to offer, he indicates now, and because of its bearing upon the use of alcohol under circumstances of deficient food. It appears to him that the ignorance of a very large proportion of women of the working-classes, in particular, regarding the proper quality of food needful to sustain the body, their inability to prepare plain nourishing food in appetizing forms, their tendency to provide whatever gives least trouble, such as the almost invariable tea bread and butter and bacon, which appeases the hunger without yielding sufficient for the repair of tissue and the liberation of energy for work, these form one of the main causes of the large amount of intemperance among the working-classes of the population. The men are not stimulated by their food, they are continually below par as regards energy for work, they know little of the buoyant elastic mood to which work is a delight, and consciously or unconsciously they feel a craving for something to stir them. So they take the spirits to raise the steam, and a vicious habit is speedily developed. "In many places," says Liebig, "destitution and misery have been ascribed to the increasing use of spirits. This is an error. The use of spirits is not the cause, but an effect of poverty. It is an exception from the rule when a well-fed man becomes a spirit-drinker. On the other hand, when the labourer earns by his work less than is required to provide the amount of food which is indispensable in order to restore fully his working power, an unyielding inexorable law of necessity compels him to have recourse to spirits. He must work, but in consequence of insufficient food, a certain portion of his working power is daily wanting. Spirits, by their action on the nerves, enable him to make up the deficient power at the expense of his body, to consume to-day that quantity which ought naturally to have been employed a day later. He draws, so to speak, a bill on his health, which must be always renewed, because, for want of means, he cannot take it up; he consumes his capital instead of his interest; and the result is the inevitable bankruptcy of his body."

One remedy for such a state of things is, not temperance or teetotal lectures, however valuable these may be, but disseminating broadcast among the people a knowledge of the uses and properties of foods, and their economic value, and teaching their daughters how to cook palatable and pleasant meals from plain and cheap materials, and how to serve them with decency if not with grace.

The value of alcohol in disease is undoubted. It would, however, serve no good purpose to consider it in this place. Its use has been now and again indicated in discussing special diseases in the first part of this work.

Wines from the Grape.

The Preparation of Wine.—Wine is the fermented juice of the grape. The fermentation takes place spontaneously and naturally speedily after the grapes have been crushed. The ferment is the same as has been noticed in speaking of the manufacture of alcohol, namely yeast, but it is not added as in producing alcohol or beer. It is already present on the exterior of the grape, and as soon as, by crushing, the juice and ferment meet one another, the process begins. The action is the same as that already described. The yeast acts upon the sugar, contained in the juice to the extent of 13 per cent, as shown in the table on p. 574, and converts it into alcohol and carbonic acid gas. Upon the extent to which the fermentation proceeds will sugar be left in more or less diminished quantity when it is completed. If very little sugar remains the result is a **dry wine**; but if a large quantity of sugar has been present in the grape juice, it will produce a larger proportion of alcohol. As soon, however, as a quantity of alcohol in a liquid has been produced above 16 per cent by volume, fermentation ceases, no further transformation of sugar will be produced, and the result will be a **sweet wine.** Now the more ripe the grape is the more rich is its juice in sugar. This ripening is produced by the influence of the sun's rays; and, therefore, it is in warm countries, such as Spain and Portugal, where the sweet strong wines, port and sherry, are prepared; and it is in more northerly regions, where the grapes can hardly be so fully matured, that the lighter and dry wines are produced—claret, hock, &c. Therefore, also, not only the climate influences the kind of wine which a particular district produces, but the quality of the wine produced in the same district, will vary with the season. Wine manufactured from grapes which have not arrived at the highest stage of maturity will be, on the same account, more acid than that prepared from fully ripe grapes. Some of the richest and most fruity wines, such as Tokay, are produced from grapes allowed to remain long on the vines, so that they develop a large amount of sugar and attain some degree of concentration of juice by the evaporation of water. In the Santerne and other districts some of the richest wines are obtained by selecting the grapes, picking them from the bunches as they reach perfection.

In the process of manufacture the grapes are first crushed, formerly by being trodden by the feet, but now usually by mechanical means. When this has been done the juice, now termed **must**, may be drawn off and allowed to ferment separately, or the whole mass is allowed to undergo fermentation together, the quality of the product varying with the process adopted. The fermentation sets in rapidly, and is completed in two or three days, or after a much longer time, according to the warmth of the place. During fermentation a froth collects on the surface owing to the rise of carbonic acid gas in bubbles. This is skimmed off several times. As the violence of the process diminishes the liquid begins to become clear by the settling of a sediment or "lees." This consists of exhausted ferment, precipitated organic matter and tartrate of potash, which the now alcoholic fluid cannot keep in solution to any great extent. The clear wine is now racked off and run into casks, where it slowly undergoes a further fermentation, and another quantity of sediment is thrown down. With the slow production of more alcohol, more tartrate of potash is precipitated in a crystalline form, called **argol**. In the course of this further fermentation, the wine is several times racked off and transferred to other casks. The material left in the fermenting vat, called **murc** or **mark**, is pressed, and the best of the liquid obtained may be placed in the casks, the muddier portion being used for inferior wine.

Now it is plain that during the process that has been indicated there is a multitude of circumstances, which will influence the character of the wine produced. If, after the grapes are crushed, the juice is expressed and fermented alone, a very different wine will be produced from that yielded by the fermentation of the juice with the skins, seeds, stalks, &c. When the juice alone undergoes fermentation a **white wine** is yielded, no matter though purple grapes have been used, for their juice is devoid of colour like the white ones. If, however, the skins are not removed, as soon as alcohol is produced it attacks the colouring matter in the skin, dissolves it out, and a **red wine** is the result. From the skins also, and seeds and stalks as well, an astringent material is derived and, thus, wine obtained from fermenting the juice along with skins, seeds, and stalks is more astringent. Again the quality varies with the rapidity of fermentation; for the slower this process, the more extensively do other changes occur besides the formation of alcohol and carbonic acid gas; these changes are the development of ethers, essential oils, &c., which give aroma and fulness to the flavour. On the other hand, if the process has been too rapid, time has not been given for these substances to form, produced as they are by slow oxidation changes, and the wine is thin and characterless. Sometimes alcohol is added to check the fermentation earlier than usual. Such wines, owing to the sugar not being nearly exhausted by the ferment, subsequently undergo slow changes which increase the bouquet and flavour of the wine, so that it matures with age. Wines which have had spirit added for such a purpose, or because they contained so small a percentage of alcohol as to be devoid of good keeping properties, are called **fortified wines**, while those which contain simply the alcohol due to fermentation are called **natural wines**. The wines of Portugal, Spain, Madeira, and the Cape are commonly fortified, those of France, Germany, and Hungary are more commonly natural wines.

Natural wines should not contain more than 7 to 13 per cent by volume of alcohol, while fortified wines contain 14 to 18.

The final process of wine manufacture is "fining." This is effected by the addition of isinglass or white of egg which carries down organic impurities and leaves the wine clear. It is allowed to remain at rest for several weeks after the addition of this agent, then it is racked off into another cask and is ready for bottling.

The Composition of Wine.—The composition of the grape has been shown on p. 574, and that of the juice before fermentation is, of course, similar. It contains water, sugar, albuminoid (nitrogenous) material, non-nitrogenous substances, other than sugar, such as gum, pectin, fat, &c., tartaric acid combined with potash, as tartrate of potash, fibre, and mineral matters, such as potash, soda, lime, magnesia, &c., in combination with sulphuric and phosphoric acid, and in the skins and stalks there are tannin and colouring matters. Now by fermentation the sugar becomes changed into alcohol and carbonic acid gas; the fermentation produces, besides, glycerin and succinic acid. Further, by the action of oxygen upon the alcohol produced, acetic acid is formed, and a substance called aldehyde which confers a peculiar smell and flavour. While, therefore, the acid of grape juice is mainly tartaric acid, the acids of wine are tartaric, acetic, succinic, carbonic, and formic, the last four resulting from the fermentation. There are also small quantities of fatty acids, and tannic acid when the skins and stalks have fermented with the juice, as in the case of red wines. Further, in the process of maturation of wine, ethers are formed by the action of acids on the alcohol. They are formed slowly and in small quantity, being present, therefore, to greatest extent in old wines, and it is owing to their presence that old wines have the fruity aroma which makes them prized. An ether, produced by the action of a fatty acid on the alcohol, is œnanthic ether to which, though it is said to be present to the extent of only one part in 40,000, the characteristic smell of wine is mainly due. It is its presence in the spirit of wine—brandy—that gives to it its peculiar flavour and odour. By the action of the various acids upon the alcohol in new wine numerous ethers are produced, which process diminishes the alcoholic strength of the wine but develops its aroma. As already said it is only in old wines that these changes have occurred to any great extent. Much of the albuminous material of the juice of the grape disappears in the fermentation process, some remains and in time is precipitated by tannin, forming part of the crust of wine. Wine also contains less mineral materials than grape juice, because much of that material cannot be kept in solution when the liquid becomes alcoholic. It is in part precipitated as the fermentation goes on, and subsequently much mineral material is deposited in the crust, such as the bitartrate of potash (cream of tartar) and phosphate and tartrate of lime.

The changes which take place in wine, then, with age, are diminution or disappearance of sugar that may have escaped fermentation, diminution of alcohol and of acidity by the production of ethers and consequent improvement in aroma and flavour, and diminution of tannin albuminous and mineral matter by precipitation as crust; colouring matter is also deposited, so that the colour is also less dark.

There is a process, known as "plastering," employed during the production of wine which alters the quantity and kind of mineral substances present. It consists in dusting over the grape juice, before fermentation, sulphate of lime—plaster of Paris or burned gypsum. The object of this is to remove some of the acid flavour. Sherry and port are almost regularly subjected to such treatment, as well as certain wines of France and Greece. Tartrate of potash is removed by this means, tartrate of lime being formed and precipitated; but sulphate of potash is also formed; it is a bitter salt and remains in solution. The tartrate of potash thus removed from the wine is one of its most valuable salts. The process, according to Hassall, "deprives the wine, in fact, of a very valuable salt, substituting another salt of an injurious character." Wines are also frequently coloured artificially by the addition of burned sugar or vegetable colouring matters, and are also artificially flavoured by the use of elder flowers and other substances.

The following table from Church shows the constituents of the chief wines in ordinary use. The percentages of alcohol present in different varieties of wine is shown on p. 667.

Constituents of One Imperial Pint of Various Wines.

	Port.		Madeira.		Sherry.		Carlowitz.		Burgundy.		Champagne.		Claret.		Hock.	
	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.
Absolute Alcohol, .	3	218	3	218	3	147	2	35	2	18	1	343	1	306	1	219
Sugar, ...	0	359	0	175	0	236	none			10	1	120	0	9	none	
Tartaric Acid, ...		23		26		24		36		24		20		31		39
Acetic Acid, ...		12		18		12		19		17		10		18		18
Ethers, ...		6		5		4		5		6		5		6		4
Mineral Matters, ..		20		33		38		16		18		20		18		16

Besides the variation in the quantity of alcohol, one notes in this table the greater proportion of sugar in port, Madeira, sherry, and Champagne, and its absence in Carlowitz, Burgundy, claret, and hock, while the acidity of the latter is greater.

It does not fall within the purpose of this work to describe the various detailed differences between the various wines, sherry, port, Champagne, their special mode of production and so on.

The Use of Wines.—The action of wine on the body is determined to some extent by the quantity of alcohol contained in it. But it is said that the presence of ethers, mineral materials, &c., considerably alters the nature of its action, so that it does not so readily tend to produce injurious changes on the body as whisky or brandy or other strongly-alcoholic liquors. It is to be noted, however, that the strong wines, such as port, are usually taken undiluted, while whisky is usually drunk largely diluted; and thus those who take the fortified wines take alcohol in a more concentrated form than if they took whisky and water. Apart from the alcohol, the presence of sugar in some wines gives them a value as food-stuffs, and the mineral matters also occasionally are useful to the body. It must not be forgotten that wines, almost without exception, interfere with digestion, if consumed to any extent (see p. 604), and interfere to a greater extent than the same quantity of alcohol, taken as whisky and water, would. This action is most marked in the case of the rich sweet wines, and least in hock and kindred wines. If wines are to be used at all, in health, preference should be given to the lighter French, German, and Hungarian wines, the clarets, hocks, and such a wine as Carlowitz, while sherry, port, Marsala, Madeira, and such wines should be in general avoided, and most particularly by dyspeptics, gouty and bilious subjects. These richer wines are often exceedingly valuable in enfeebled conditions, but are not advisable for ordinary employment. The Australian wines now freely employed afford an excellent supply of light wine for those who insist upon some such beverage daily. They are natural wines, of soft and delicate flavour, and with an aroma of their own. Anyone who believes he needs some stimulant to his appetite cannot do better than use such a light one, particularly in face of the difficulty of obtaining a good claret. If one really needs and derives benefit from such a stimulant with food, let him try a glass of good claret or similar wine, made up to a tumblerful with boiling water, and sipped throughout the meal. Sparkling wines, and particularly of a dry kind, and specially a dry Champagne, are often exceedingly useful in disease, when the stomach rejects food and other kinds of stimulant. The sparkle, due to the escaping carbonic acid gas, is grateful and often soothing to the stomach, and the restorative action of such wines is more rapid than that of still wines or ordinary spirits.

The Adulteration of Wines.—It is useless to speak of the value of wines without noting the enormous difficulties in the way of obtaining what is genuine. It does appear that actually good wine is almost beyond the reach of any but those who are able to pay a good price. The fact that wine is valuable under certain circumstances is, therefore, qualified by the fact that it is only procurable by the few. This will be sufficiently shown by the following extracts from Dr. Hassall's book on *Food and its Adulterations*. "Scarcely a natural sherry is to be met with in this country. The very finest and purest sherries imported . . . are fortified with grape spirit only, or with grape spirit, grape sugar, and grape colouring; . . . but the great bulk, we fear, of the sherries consumed in Great Britain, contain foreign spirit, foreign sugar, and foreign colouring, and are, in fact, mixed and adulterated." "A kind of sherry is manufactured in this country, the basis of which is pale malt and sugar-candy, a small quantity of French brandy and inferior wine being added to flavour the mixture." "Port wine is subject to a large amount of adulteration before it reaches this country; after its arrival here it is frequently subjected to further sophistication. Sometimes it is diluted, brandied, and then coloured by the mixture termed Jerupiga, or by means of logwood. The brilliancy of the colour is sometimes increased by means of alum, and, if turbid, it is cleared by gypsum, while increased astringency is imparted by means of oak-sawdust. Not infrequently peculiar flavours or bouquets are artificially communicated to port wine; the principal substances used for this purpose are extract of sweetbriar, orris-root, and cherry-laurel water."

Wines from Fruit other than the Grape.

Wine might be produced from any kind of fruit containing grape-sugar. The fruit is crushed like the grape, and the juice allowed spontaneously to ferment.

Cider is wine produced from crushed apples. After the fruit has been crushed, the juice is expressed, and then allowed to ferment, no yeast being added. The character of the liquor produced depends upon the kind of apple, whether it has been kept till fully mature, whether the juice has been expressed immediately after crushing, upon the length of time fermentation has been allowed to go on, &c. It contains usually from 5·21 to 9·87 per cent of alcohol by volume. If allowed to ferment too long, acid is readily produced, resulting in a sour thin liquid. In Normandy many varieties of apple are grown for the manufacture of cider.

Perry is prepared by a process similar to cider from pears. It contains usually about 7·26 per cent of alcohol.

Gooseberry Wine, Mulberry Wine, &c. may be prepared in similar ways from their respective fruits.

Beer and other Malt Liquors.

Preparation and Composition of Beer.—Malt liquors are prepared from malted grain, usually barley, prepared by the method already described at the beginning of the paragraphs on alcohol. The malt is mashed as explained in these paragraphs, and the process carried on in a similar way to that for the production of alcohol, till the wort has been produced. The wort is then boiled, and here the first difference arises, consisting in the addition to the wort of hops. These are the female flowers of a plant belonging to the natural order *Urticaceæ*, the *Humulus lupulus*. They are grown to greatest perfection in Kent and Sussex. They contain an oil, the oil of hops, a bitter principle called lupulin, which are the two chief ingredients from the brewer's point of view, a resin, tannin, and mineral matters, &c. It is for the flavour and bitter, as well as for their preservative qualities, that hops are employed; and they impart an aromatic and tonic character to the infusion. The hops are added to the wort in the copper, in quantity dependent upon the liquor to be produced, for ale about 8 pounds of hops being added to one quarter of malt and 180 gallons of water, this quantity yielding 108 gallons of ale, water being lost in the course of the various processes. After being boiled the liquor is drawn off, strained, cooled to a proper fermenting temperature, and the yeast added. In three or four days the process is completed. The fermentation is not carried so far as in the production of alcohol, since in the manufacture of beer it is desired to leave some sugar unconverted. After fermentation the liquor is allowed to clarify, "finings" of isinglass being sometimes added to facilitate that process. The beer is then racked off into casks for use.

The kind of malt liquor produced depends upon the kind and quantity of malt used, the quantity of hops added, the extent to which fermentation is carried, and on various other circumstances. The greater the quantity of malt used, the higher is likely to be the alcoholic strength of the beer. Pale malt is used as a basis of all malt liquors, dark malts being employed in addition to give the colour to stout, porter, &c. Ale is manufactured from the pale variety only.

Malt liquors contain water, alcohol, and sugar, dependent upon the extent of the process of fermentation, albuminous substances of the malt extract, carbonic, acetic, lactic and succinic acids produced by the fermentation, bitter and colouring matters, and saline substances. The kind of water with which beer is brewed is understood to affect its quality. Thus the special character of Burton-on-Trent brew is believed to be due to some extent to the water, which is rich in mineral constituents.

The following is an analysis of a stout:—

Alcohol (by weight), ...	... 5·51	per cent.
Soluble Albuminoids,	... ·69	,,
Sugar, Dextrin, &c., ...	... 6·74	,,
Acetic Acid, ...	... ·05	,,
Lactic Acid, ...	... ·18	,,
Mineral Matters, ...	... ·37	,,

The following table from Church indicates the constituents of stout and ale:—

Constituents of One Imperial Pint of Ales and Stout.

	London Stout.		London Porter.		Pale Ale.		Strong Ale.	
	oz.	grs.	oz.	grs.	oz.	grs.	oz.	grs.
Water, ...	18	343	18	412	18	409	17	399
Alcohol, ...	1	74	1	10	1	12	2	18
Acetic Acid, ...		22		16		17		21
Extractives,[1]	1	25	1	3	0	372	2	42
Mineral Matter, .		22		18		10		30

Twenty ounces of beer (one pint) yield about one ounce of absolute alcohol.

Lager Bier (Munich) contains 5·1 per cent of alcohol, and 5 per cent of malt extract.

White Beer (Weiss Bier) contains 1·9 per cent of alcohol, and 5·7 of malt extract.

The Value of Malt Liquors.—Besides the alcohol, whose effects have been already discussed, malt liquors, as shown by the tables, contain undoubtedly nutritive materials in the shape of albuminoids, sugar, &c., derived from the malt extract. These materials are contained in largest amount in stout porter and strong ale. Such liquors thus possess stimulating, nutritive, and tonic properties, the latter being most marked in the pale ales. When taken in any quantity they tend to interfere with the due combustion of fats, and probably also carbo-hydrates in the body. In consequence a fat and bloated appearance is apt to be induced, more particularly as the liquor contains considerable quantities of fattening material in the shape of sugar. Moreover, the same interference with the natural action of the bodily organs leads to an accumulation within the system of imperfectly oxidized substances, resulting in impaired digestion, interference with the functions of the liver, gouty and bilious affections, nervous irritability and the like. According to the calculation already made (p. 672) the use of beer should be restricted to one pint per day. Stout and porter are frequently found valuable in the treatment of diseases of mal-nutrition, and they are in frequent use by nursing mothers. It would be well, however, if the employment of such agents in general weakness or disease were regulated by medical advice.

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[1] This includes albuminoids, sugar, dextrin, &c., derived from the malt and hop extract.

SECTION III.—AIR, VENTILATION, AND WARMING.

Air.

The Necessity for Air.

The Atmosphere:

Physical Properties of Air—Effects of Temperature and Pressure—
Effects on the Body of Increased and Diminished Pressure—Mountain Sickness—Cupping Glasses.

The Composition of the Air—
Oxygen and Nitrogen—Difference in Quantity of Oxygen in a given Volume of Air according to Pressure and Temperature—Ozone.

Carbonic Acid of the Air;

Impurities in the Atmosphere—Dust in the Air—Germs in the Air—Observations with the Aeroscope;

Purification of the Air.

Ventilation.

Air of Confined Spaces:

Air Vitiated by Breathing—Smell as a Test of Impurity;

Quantity of Fresh Air required per head per hour.

Effects on Air of Burning of Candles, Gas, Fire, &c.;

Moisture in the Air.

Methods of Ventilation:

Ventilation by Diffusion of Air through Walls—Permeability of Walls—Construction of House Walls, Foundations, &c., in view of this;

Position of Openings for Ventilation;

Inlet Ventilators—Window Ventilation—Sheringham's Ventilator—Tobin's Tubes;

Outlet Ventilators—Ventilators in Chimney—Shaft Ventilators, Boyle's, Watson's, M'Kinnell's;

The Size of Ventilating Openings;

Ventilation by Chimney—Causes of Bad Draught.

Warming.

Conduction, Convection, and Radiation of Heat.

Heating by Open Fireplace and by Hot Air contrasted:

The Construction of the Ordinary Grate—Teale's Economizer;

The Galton Grate;

German Stoves and Gas Stoves.

AIR.

The Necessity for Air.—In the first part of this work, in Section IX. A, the process of respiration has been considered, and the means by which air from the external atmosphere is taken into the lungs have been explained in detail. The reason for the introduction of air has also been briefly set forth, namely that oxygen is necessary for the life of the tissues, and that the blood flowing in the fine blood-vessels of the lungs obtains oxygen from the air introduced, and carries it to the tissues (see pp. 249, 257, and 261). Moreover, the purpose served by the oxygen derived from the air is sufficiently indicated in the early portions of Section I. of Part II., where the energy of the body is shown to be derived from food-stuffs by a process of combustion, or oxidation, or union with oxygen (see pp. 527 and 531). The food-stuffs themselves contain oxygen as part of their chemical constitution, some to a great extent, like starch and sugar, others to a less extent, like fat; and thus they may undergo partial oxidation without any added quantity of oxygen being supplied. But none of them contains sufficient oxygen for complete combustion either outside or inside the body.

Thus sugar	contains	51	parts of oxygen	in	every	100
starch	,,	49	,,	,,	,,	100
fat	,,	10	,,	,,	,,	100

But these are totally insufficient quantities of oxygen to effect complete combustion of the food-stuffs, &c.

For 100	parts of	sugar	require	103	of oxygen for complete combustion.
,,	,,	starch	,,	120	,, ,,
,,	,,	fat	,,	293	,, ,,

There exists, therefore, the necessity of introducing into the body a very large quantity of oxygen wherewith the food-stuffs may combine to yield energy for work and heat; and this large quantity is introduced from the atmosphere by the process of breathing. We have already commented (p. 619) on the fact that different climates require different foods, not only because more heat is necessary to maintain the bodily temperature in one—a cold climate, and less in another—a hot climate, but also because sufficient oxygen cannot readily be introduced in the hot climate, where the atmosphere is rarefied, to oxidize such foods as fat; while it is easily introduced in the cold climate, where the atmosphere is condensed.

It is important then to consider the nature of the atmosphere, under varying circumstances, since it plays so important a part in the processes of life.

The Atmosphere is the gaseous envelope which surrounds the earth. At a distance from the earth, not positively determined, it ceases; the distance being usually set down at from 40 to 45 miles on an average. Now air has weight, though that is not immediately apparent. If a flask, in the condition in which it is usually called empty, but when it is really filled with air, be balanced on a scale-pan, and then by means of an air-pump if the air be withdrawn, and the flask be then replaced on the pan, it will be found lighter, the loss being the weight of air removed. It has been found that 100 cubic inches of air weigh 31 grains at a temperature of 32° Fahr. and when the barometer registers a pressure of 30 inches of mercury. At this same temperature and pressure a cubic foot of dry air weighs 566⅘ grains. Air can be compressed; its particles which tend to expand, to repel one another, can be pressed more closely together, in which case the bulk of air can be diminished. At the surface of the earth, then, at the level of the sea, the atmosphere exerts a certain pressure, the pressure or weight of the 45-mile layer of air between the limit of the atmosphere and the given place. The layer of air nearest the earth is bearing the weight of all the layers of air above it; and since air is compressible, the layer next the earth will be more compressed, will be more dense, that is to say, than any other layer higher in the atmosphere. So that as one ascends in the atmosphere the pressure and density will diminish. **The pressure of the atmosphere** at the sea-level is, as a mean, equal to the pressure of a column of mercury 29·92 English inches high. So that in a tube from which air has been withdrawn mercury will rise to that height by the atmospheric pressure. This is the height of the barometric column. The pressure of this column of mercury is equal to that of a column of water 32 feet high, water being about fourteen times lighter than mercury. This pressure is in round numbers equal to 15 pounds to the square inch. On everything at the earth's surface this pressure is exerted, on every part of our bodies also, on the outer portion of the body, and by the windpipe and bronchial tube on the inner surface of the lungs, &c. We feel no weight because the pressure is everywhere uniformly distributed. If one descends a mine the atmospheric pressure increases; as one ascends a mountain the pressure diminishes. If a very high ascent is made, whether by climbing a high mountain or ascending by a balloon, various effects are produced on the body, which taken together form what is called **mal des montagnes, or mountain sickness.** Among these symptoms are loss of appetite, thirst, sickness, vomiting sometimes of both bile and blood, frequent and difficult breathing, quickened irregular weak pulse, great muscular fatigue, headache, depression, and dimness of vision, congestion of the blood-vessels of the skin, and bleeding from the nose, eyes, ears, bowels, &c. These effects are partly experienced at a height of 10,000 feet, and almost certainly at an elevation of 17,000 feet, though they appear more quickly in some persons than in others. The causes of these symptoms are partly mechanical and partly chemical. The diminution of pressure outside the body, that within the blood-vessels and cavities of the body remaining the same, is sufficient to account for the rupture of blood-vessels; while the rarefied condition of the atmosphere, resulting inevitably in deficient oxygen being obtained, accounts for most of the others. Similar effects have been produced by submitting persons, in cylinders constructed for the purpose, to more or less rarefied atmospheres. On the other hand, when the body is submitted to an atmosphere whose pressure is greatly above the normal, as in a diving-bell, other effects are produced, diminution of rapidity of pulse and of breathing, increased appetite, &c., and ill effects follow a very high pressure. Whenever anyone has been subject to a very high pressure, as by working in a diving-bell or in caissons in deep water, return to the normal pressure should be effected gradually, not suddenly.

The effects of pressure on the body are illustrated by the action of cupping-glasses. These are small bell-jars, and they are applied in the following way. A penholder or similar piece of wood has a small piece of lint or cotton, &c., wrapped round one end, which is then dipped in spirit of wine, to make a small torch. The cupping-glass is placed upon the skin and raised on one side to permit of the penholder being passed inside the cup. The spirit is then lighted, and the flame introduced for an instant into the cup and immediately withdrawn, when the cup is instantly pressed upon the skin all round. Vapour from the flame drives the air from the cup, and after the torch is withdrawn this vapour condenses. Air not being able to enter, a partial vacuum is created. Thus the pressure on the skin covered by the mouth of the cup is much less than that beyond it. In consequence the skin and flesh beneath it rise up into the cup, and the blood-vessels of the skin become congested with blood. The effect of this is to draw the blood from deep parts, and thus cupping-glasses used to be employed to withdraw blood from the seat of deep inflammation.

The **density of the air** varies also with the temperature. A high temperature causes the air to expand, and therefore to become lighter—that is, of two equal volumes of air at different temperatures that of the high temperature will weigh less than that of the low temperature. It is changes in the temperature due to local causes that occasion winds, the currents produced being the means for re-establishing equilibrium.

It is a remarkable circumstance that air has little power of absorbing heat, while it readily transmits it. Thus the heat-rays from the sun pass through the air without heating it to any great extent. When these rays fall upon the earth, it absorbs them and the earth's surface becomes warm. The layer of air in contact with the earth is then heated, because of its contact with the earth, and rises, cold air flowing in to replace it, to be warmed and in turn to rise, and thus a movement of air is created. The result of this is evident. If the air absorbed the heat-rays of the sun to any extent it would become unbearably warm and too rare for breathing purposes; while by the earth becoming warm and gradually giving out its heat, sudden changes are modified, and a degree of warmth kept up after sunset, coolness gradually, not suddenly, setting in.

The Composition of the Air.—The atmosphere consists chiefly of two gases, oxygen and nitrogen, not in a state of chemical union, but simply in a condition of mechanical mixture. It is somewhat singular that, in spite of varying conditions of place, climate, &c., the proportion of these two gases remains practically uniform, namely:—

$$\left.\begin{array}{l}\text{20·9 per cent of oxygen, and}\\ \text{79·1 ,, ,, nitrogen,}\end{array}\right\}\text{by volume.}$$

If the estimation is made according to weight, then 100 parts of air contain

23 parts of oxygen, and
77 ,, nitrogen.

Now it has been said that, at a temperature of 32° Fahr. and a pressure of 30 inches of mercury, a cubic foot of dry air weighs $566\frac{3}{4}$ grains. Taking the proportion of oxygen and nitrogen by weight as 23 and 77, then of this $566\frac{3}{4}$ grains, in round numbers,

$436\frac{1}{2}$ grains are nitrogen, and
$130\frac{1}{4}$,, oxygen.
Total, $566\frac{3}{4}$

But it has been said that air expands with heating. A cubic foot of air at 32° Fahr. will be more than a cubic foot at 80° Fahr.; in other words, a cubic foot of air at 80° Fahr. will weigh less than a cubic foot at 32°. It weighs, indeed, only $516\frac{1}{3}$ grains, containing fully

$397\frac{1}{2}$ grains nitrogen.
$118\frac{3}{4}$,, oxygen.

Then as to pressure, the cubic foot of air at a pressure of 30 inches contained

$130\frac{1}{4}$ grains of oxygen;

but at a pressure of 25 inches of mercury, equal to an ascent in the air of about 5000 feet, the cubic foot of air is lighter and contains only

108·6 grains of oxygen.

Thus suppose a man breathing fifteen times a minute in a cold atmosphere, and obtaining thereby a certain quantity of oxygen. In a warm atmosphere, if he is to obtain the same quantity of oxygen, he must breathe faster. Similarly, if he breathes at a certain rate at the sea-level, and thereafter ascends a high mountain, his breathing must be quickened if he is to introduce the same quantity of oxygen into his blood.

Why does a man in good health usually feel buoyant, active, and able to do a considerable amount of hard work in cold weather? while in hot weather the same man feels dull, less disposed to activity, and certainly indisposed to hard work. The facts that have been stated supply part, at least, of the explanation. Hard work means increased liberation of energy in the body, increased oxidation changes, implying increased supplies of oxygen, obtained with comparative ease in the cold weather, when with every cubic foot of air breathed he introduces $130\frac{1}{4}$ grains of oxygen, but obtained with greater difficulty in hot weather, when he can introduce less and less oxygen with every cubic foot of air breathed, as the temperature rises, and thus cannot liberate energy in his body with the same rapidity.

In addition to oxygen and nitrogen air contains 4 parts of carbonic acid gas in 10,000, the quantity increasing slightly up to an elevation of 11,000 feet above the sea-level and then decreasing.

Watery vapour is also constantly present, varying in amount with the temperature of the locality, the higher the temperature the greater being the quantity of watery vapour which the air will hold. Thus at a temperature of 100° Fahr. each cubic foot of air will hold nearly 20 grains of water, while at freezing temperature each cubic foot will hold only 2 grains. As the air cools down from 100° Fahr. to freezing-point the watery vapour will, in consequence, separate out from it and be deposited. This is the explanation of the formation of dew. When the sun has set, the heated air rising from the earth deposits moisture as soon as it comes into contact with colder strata. When air at a certain temperature contains as much watery vapour as it can hold, it is said to be saturated for that temperature. If the temperature rise it can take up more vapour, and has got some drying power it had not at the lower temperature.

Besides the gases named and watery vapour there are present in air other substances, some of them gaseous and others solid; but these are rather to be considered impurities, and will be spoken of under that heading. It will be of much interest to note the value of these different constituents of the air.

Oxygen is a gas, colourless, and without taste or smell. It is the most abundant of all the elements in nature, and unites readily with almost every substance. When a substance unites with oxygen it is said to become **oxidized** and the process is called **oxidation**. This process may occur slowly or rapidly. When it occurs rapidly, the heat produced by the action is very apparent and the substance may burst into flame, and thus heat and light are produced. Thus when a fire burns, as already explained (p. 527), the carbon of the coal unites with the oxygen of the air. When a candle burns the substance of the candle unites with the oxygen of the air, the carbon of the substance uniting to form carbonic acid gas (CO_2, p. 651) with the oxygen, and the hydrogen of the substance uniting with oxygen to form water (H_2O, p. 636). When we burn coal-gas to give us light, the same thing happens. A very simple but very instructive experiment may easily be performed. Let a little wire stand be made so that two pieces of candle can be fixed upon it, one low down, the other near the top. Let this be set upon a large dinner-plate, let us say. Then let a bell-jar be taken, or such a glass shade as is used to cover a large pot of ferns or such like plants, of a size that the plate can hold. Light the pieces of candle, cover with the bell-jar, and pour a little water on the plate, to make a layer sufficient to cover the lip of the jar all round, so that no fresh air can enter. At first both pieces of candle will burn quite brightly. Soon drops of moisture will form on the inner surface of the glass jar, the moisture formed by the union of the hydrogen of the candle oil with the oxygen of the inclosed air. After some time the light will be perceptibly feebler, and the flames will become smaller, the lower one more slowly than the upper. By and by the upper flame will die out, the lower still burning feebly. If the bell-jar be lifted when the lower one is about to die out, it will immediately start again burning with vigour. The meaning of all this is that the oxygen of the inclosed air has gradually been consumed, and as the jar contained increasingly less and less the flames became feebler, because oxidation was less rapid. As the burning went on, not only watery vapour but carbonic acid gas was produced, which will not support combustion but will extinguish it. This gas, though heavier than air, rises to the upper part of the jar, because heated gas ascends and pollutes the atmosphere where the higher flame is burning, and as soon as sufficient has been produced it drowns it out, while the lower piece of candle still finds oxygen in the lower and colder part of the jar. When this lower piece is also about to go out from want of oxygen and from presence of carbonic acid gas, the raising of the jar supplies fresh air and it begins to burn again vigorously. As already explained this process of oxidation goes on in the living body, alike of animals and men, as part of the absolutely necessary processes of life. With a diminished supply of oxygen only feeble life could be maintained, just as only a feeble flame could burn. So that if a man or an animal were placed in a confined space, into which no fresh air could enter, his life would gradually become extinguished like the candle flame. The atmosphere, then, is the common source from which are drawn supplies of oxygen to maintain combustion for yielding heat and light, &c., and for the maintenance of life.

Furthermore the oxygen of the air is one of the most active of purifying agents. All organic matters exposed to the air undergo an oxidizing process, by which they are reduced to simple substances. Putrefaction and decay are processes of this kind carried on by the agency of minute living organisms. Thus all dead animal or vegetable matter undergoes oxidation and is reduced from useless and perhaps hurtful forms to valuable and harmless substances. So that the atmospheric oxygen is one of nature's great purifying agents.

One can obtain pure oxygen from substances which contain it in large quantity. Thus chlorate of potash, which is a chemical compound of chlorine oxygen and potassium, contains it in abundance. If chlorate of potash be heated in a flask oxygen is given off and can be led by a tube and collected in a jar over water. If a piece of wood with a bright glowing end be thurst into a jar of oxygen, it will immediately burst into flame and burn with great rapidity and brilliance. Such rapidity of combustion is not desired, neither is it possible for living beings to breathe anything like pure oxygen for any time with safety. While, therefore, it is the oxygen that is the valuable constituent of the atmosphere, it is necessary to be present in a diluted state.

The **nitrogen** of the atmosphere is a gas which performs the needful duty of diluting the oxygen. It also is a colourless gas without taste or smell. It does not burn and will not support combustion. A lighted candle thrust into a jar of nitrogen will immediately go out, not because the nitrogen extinguishes it, but because of the absence of oxygen to enable it to burn. It is an indifferent gas, with no active properties. In the atmosphere it acts, therefore, simply as a diluting agent for the oxygen. Its value, however, when in chemical combination, specially in the formation of organic substances like albumin (p. 536) has already been insisted on.

Ozone is a form in which oxygen exists, in which it has a peculiar smell and a very high degree of chemical activity. It is readily produced in air by passing electric sparks through it, and it is naturally produced in the atmosphere by the discharge of lightning. The activity of ozone in the work of oxidation and in the destruction of organic substances is much greater than that of simple oxygen, and an atmosphere rich in ozone is certain to be one of great purity. Perhaps this accounts for its absence from the air of towns, and its presence in the fresh air of the country.

Carbonic Acid Gas of the Air.—If, then, some one may say, with every act of combustion oxygen is consumed, and if life implies the removal of oxygen from the atmosphere, the quantity of oxygen daily removed from the atmosphere must be enormous. Moreover all this means not only the consumption of oxygen but also the production of carbonic acid gas, and this gas (which has been considered on p. 651) is inimical to life. In two ways the atmosphere is daily being vitiated to an enormous extent. This is all quite true. Thus De Chaumont makes the following calculation: "At the lowest estimate there cannot be less than 300,000,000,000 cubic feet of carbonic acid gas generated in London in a year from combustion and respiration, or a mean of 822,000,000 per day, or 34,250,000 per hour, or more than 9500 cubic feet per second. Now this is sufficient to double the normal amount of carbonic acid in 23,750,000 cubic feet of air per second, or in about 14 cubic miles every twenty-four hours, or more than 5000 cubic miles per annum. This represents a mass of air of the area of the metropolis, but extending upwards to ten times the height of the Himalayan Mountains." It has been estimated that in Paris one hundred millions of cubic feet of carbonic acid gas are daily produced, one-tenth by the respiration of animals and human beings, and the remainder by processes of ordinary combustion. How is it that under such circumstances all life does not speedily cease from the surface of the globe? The marvellous economy of nature is not unequal to the gigantic task of disposing of the enormous mass of carbonic acid daily produced upon the earth's surface. In the open air the carbonic acid gas is allowed to accumulate nowhere. By diffusion (see p. 258) the carbonic acid produced rapidly mixes with the atmosphere, while variations in temperature producing currents of air and so forth make the mixture still more rapid and thorough. Finally, while men and animals are constantly removing oxygen from the atmosphere and then returning it, combined with carbon, as carbonic acid gas, plants are as persistently reversing the process, *under the influence of sunlight* (see p. 258), removing the carbonic acid gas from the atmosphere, appropriating the carbon, to build it up into their structure, and returning the oxygen to the air. So that the purification of the atmosphere by vegetable life can always keep pace with its defilement by animal life, wherever the laws of nature are allowed their undisputed sway. As a consequence the remarkable fact has been shown that everywhere, *in the open air*, the proportion of carbonic acid gas is pretty nearly the same, as the following list shows:—

Over the open sea	the proportion	is	·032	per cent.
At Portsmouth	,,	,,	·032	,,
,, Manchester	,,	,,	·037	,,
,, Aldershot	,,	,,	·040	,,
,, Tower of London	,,	,,	·042	,,
,, Chelsea	,,	,,	·047	,,
,, Munich	,,	,,	·050	,,
,, Arctic Regions	,,	,,	·055	,,
,, Top of Mont Blanc	,,	,,	·061	,,
,, Chamounix	,,	,,	·063	,,

Impurities in the Atmosphere.—Besides oxygen, nitrogen, carbonic acid gas, and watery vapour, there are many other substances found in the atmosphere, some gaseous and some solid, dependent upon locality, upon the nature of the earth's surface, upon the proximity to towns, manufactories, &c., upon animal and vegetable exhalations, and so on. The gaseous impurities are specially the product of manufactories, chemical works, &c., and are such as sulphurous and sulphuric acid, hydrochloric acid, ammonia, nitric acid. The two first of these result in quantity from the burning of coal, because of the sulphur it contains, and from the burning of gas made from common coal. The late Dr. William Wallace, city analyst for Glasgow, expressed the opinion that a million tons of sulphur contained in coal, are burned in Great Britain annually, producing fully three million tons of oil of vitriol. There is also a large quantity of vitiating gases passed into the atmosphere from manure and refuse heaps, from decaying organic matter, animal and vegetable, from sewage and so on. Salt is found present in air, derived from the ocean, even at considerable distances from the coast.

The nature and extent of the solid foreign impurities are more easily estimated. The fact that the atmosphere everywhere contains myriads of particles is matter of common observation. When a beam of sunshine passes into a darkened room through a chink in the shutter, the pathway of the beam is marked out by a white track through the darkness, a pathway formed of multitudes of dancing particles. But for the presence of these minute foreign substances, the pathway of the beam would be invisible. They catch the light and reflect it, and thus reveal the course of the light (see p. 388). If a lighted spirit-lamp be held under the beam, the white beam will at once appear as if cleft in twain by a dark gulf, as if it had been cut in two. The hot flame has destroyed the dancing particles immediately above it, and the light is passing across a space from which the particles have been removed, so that its pathway is no longer visible. Beyond the hot flame the track is white as before. This shows that the majority of these particles are organic in their nature since they will undergo combustion with such effects. How by various observers and by varied experiments it was finally established that the air-ocean which surrounds our earth was nearly everywhere teeming with life, like the liquid ocean of the sea, though of microscopic size, has been already detailed on p. 385 and subsequent pages. One of the most complete investigations into the character of atmospheric particles was conducted, less than fifty years ago, by a German, Ehrenberg, who investigated the exact nature of the elements of common dust found in houses, libraries, museums, towers, the Bernese Oberland, the High Alps, Lebanon, and the Himalayas. Later Dr. Douglas Cunningham, of the Indian army, made a most elaborate report to the Indian government on the foreign materials present in air, and numerous observers, German, French, and English, more particularly Dr. M. P. Miquel, of the observatory of Montsouris in the southern portion of Paris, have made careful and detailed observation on the particles present in atmospheric air at varying seasons and under a variety of circumstances.

The results of all these observations go to show the continual presence of particles, derived from the mineral, vegetable, and animal kingdoms, in the atmosphere. The wind carries into the atmosphere, even to great heights, sand, dried particles of mud, particles of coal, iron, &c., varying with the geology of the country and with the nature of the manufactures carried on in it. Dust raised by wind-storms may be carried over great distances. In Berlin atmospheric particles have been found, which had been carried from the deserts of Africa. The enormous numbers of these dust particles, invisible to the unaided eye, which may be present it is almost impossible to conceive. John Aitken, F.R.S.E., using a method of counting them, devised by himself, estimated that

In fair weather each cubic inch of external air contained	2,119,000
In rainy ,, ,, ,, ,, ,, ...	521,000
While in a room ,, ,, of air contained..............................	30,318,000
And ,, ,, ,, ,, from near the ceiling contained	88,346,000

"It does seem strange," says Mr. Aitken, "that there may be as many dust particles in 1 cubic inch of the air of a room at night when the gas is burning as there are inhabitants in Great Britain, and that in 3 cubic inches of the gases from a bunsen flame there are as many particles as there are inhabitants in the world."

An apparatus employed for collecting particles present in the atmosphere is called the **aeroscope**, of which one form is shown in Fig. 268. The centre piece contains a disc perforated by holes round the side, and having in the middle a microscopic slide, fixed by clips. In front of this is fitted a funnel-shaped piece, the inner end of which comes to a fine point, and opens just in front of the centre of the glass slide. Behind is fitted a tail-piece which keeps the funnel always opposite the direction from which the wind is blowing. The aeroscope is fitted to the top of a post, fixed in the ground, so that it may revolve with the wind. A drop of glycerine is placed on the centre of the slide. The air blowing into the funnel is directed by the fine point on to the drop of glycerine, which thus catches many of its contained particles. The air then escapes through the holes in the disc. Dr. Cunningham used such an arrangement, and exposed different slides to the wind for a varying time, twenty-four hours or more, and then examined the slides with the aid of a microscope. Fig. 269 exhibits the contents of a part of one of his slides. By such means the air has been shown to contain, besides the mineral substances, mentioned above, grains of starch, the pollen grains of various plants, spores of cryptogamic plants, hairs of nettles and other plants, fragments of woody fibre, cotton, fragments of vegetable tissue, minute insects, diatoms, scales of insects, hairs of rabbits and bats, plumes of feathers, minute animals of the worm class, and so on. In towns fragments of shoe leather, particles of horse-dung, fibres from clothing, &c., have easily been recognized, picked up by the wind from the streets. All kinds of germs, which have been described in detail on p. 387 have also been found.

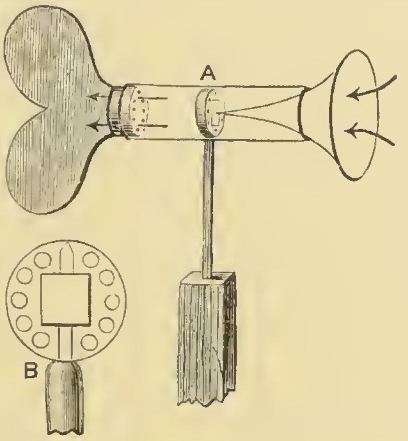

Fig. 268.—Aeroscope of Dr. Cunningham.

The use of the ordinary aeroscope, figured in Fig. 268, does not permit the number of atmospheric particles present in a given quantity of air to be counted. This more recent and more elaborate methods permit being done. Miquel in particular, has devised most ingenious methods of doing this, with the object of discovering how atmospheric germs were affected in number by rain, temperature, &c.

He found that the number was much diminished after rain. He also showed that if the air were not too dry, the number increased as the temperature of the air rose, but if the heat of the atmosphere passed a certain point, the number rapidly fell. After prolonged drought, moreover, the number diminished, moisture as well as heat being necessary for germ life. With the advent of cold weather, rapid diminution occurred. Thus from May to September the number of germs in the atmosphere about Montsouris Observatory was large, but with the advent of December the fall occurred and the number remained small till the advent of warmer weather in May. Montsouris is situated in the outskirts of Paris, so that the wind coming in one direction blows over the open country, while when it blows from another it passes over the city. Miquel found that the wind which passed over Paris before reaching the observatory was always more laden with germs, picked up from the city, than that blowing direct from the country. He also always found the air more vitiated in the centre of the city than in his suburb. Moreover Miquel tried to find whether there was any discoverable relation between the amount of infectious disease in Paris and the number of germs in the atmos-

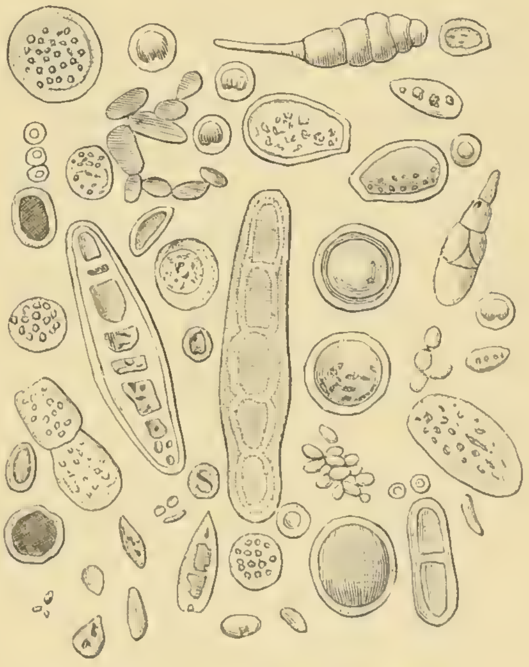
Fig. 269.—Atmospheric Organisms.

phere. He obtained the weekly returns of deaths from infectious disease in the city, and compared them with his tables of atmospheric life. At first he found no very striking similarity. But he bethought himself that it was unlikely that there would be any relation between infectious disease and the number of germs in the atmosphere about his observatory in the suburbs. So he transported his apparatus to a house in the centre of the town and proceeded to make observations. Then he obtained a very remarkable set of coincidences, for he found that whenever the weekly returns showed an increase in infectious disease his observations showed a rise in the number of air germs, and when the number of cases of disease fell, so also did the estimated number of organisms in the air. On several occasions the resemblances were very well marked, a great and rapid rise in the amount of infectious disease having an exact counterpart in a sudden great increase in the number of atmospheric organisms.

The Purification of Air of confined spaces is effected best by proper ventilation by methods already described. A large number of substances, solid, liquid, and gaseous, have also been used to effect the same purpose by chemical means. Thus dry charcoal, preferably animal charcoal, placed in saucers or other shallow vessels in the apartment, absorbs vapours and oxidizes animal emanations contained in them with great rapidity. It is said to be specially useful for air polluted with sewage gases. Solutions of Condy's red fluid, permanganate of potassium, are used in the same way. Carbolic acid in solution may also be used, placed in saucers, or sprinkled about the apartment. Chlorine gas destroys organic substances, and may be slowly disengaged in a room from chloride of lime moistened with water and placed in a shallow dish. If it be moistened with dilute sulphuric acid (oil of vitriol) the gas is disengaged rapidly. The fumes, however, are very irritating, and cannot be employed to any extent in an occupied room as the other substances can be. Iodine has also been used, being diffused through an apartment by allowing it to fall drop by drop on a hot plate and by other means. Sulphurous acid is employed for the same purpose by burning ordinary sulphur, but it also cannot be employed in an occupied room. Charcoal, Condy's fluid, and chlorine actually destroy by oxidation organic matters in contact with them, but the weak solutions of carbolic acid do not. The carbolic acid will arrest the growth of organisms, but preserves rather than destroys them. Some of these substances may be employed in the filter or troughs of inlet ventilators, and the ingoing air may thus be purified. The purification of rooms after infectious disease is described on p. 396.

VENTILATION.

Air of Confined Spaces.—Air, it has been already noted, undergoes constant defilement from the respiration of men and animals, from the burning of various substances, and by emanations from decaying animal and vegetable refuse. When natural laws are allowed full play, this vitiation is rapidly counterbalanced. The air rapidly mixes, animal and vegetable substances are speedily oxidized by the action of the oxygen of the air and by sunlight, and a normal standard of purity is easily and constantly maintained. If, however, the operation of natural laws is hindered or set aside, as by air being inclosed within confined spaces, so that free communication with the external atmosphere is prevented, then the impurity of the air is liable to become speedily marked. Wherever air is thus confined, and is at the same time liable to impurity by respiration, &c., it becomes necessary to provide special means of communication with the outside air, for the removal of the vitiated air and its replacement by a fresh supply. To such means the term ventilation is applied. To understand the full meaning of the word, it is necessary to have a correct appreciation of the nature and extent of the alterations thus produced on the air of inclosed spaces, and the effects of the alterations upon the healthy body.

Air Vitiated by Breathing.—Suppose a completely inclosed space inhabited by one or more persons, what changes does the air undergo? Oxygen is removed from it, carbonic acid gas is added to it, the amount of watery vapour is increased, and, besides, the air has added to it certain animal products, difficult to define, given out from the lungs and given off in the perspiration, &c., from the surface of the body. It is to these organic matters that the stuffy odour of an atmosphere is due, which has been rendered impure by the respiration of men or animals. The extent to which these various changes are injurious was shown long ago by an experiment performed by an Italian, Polli. He placed animals in inclosed spaces, containing the same quantity of air, but one of the spaces had an arrangement by which, by means of lime, the carbonic acid gas and moisture produced by the breathing of the animal were absorbed, another was provided with charcoal which absorbed and destroyed the organic exhalations, while a third had no arrangement for removing any impurity at all. Thus the air in the first space would be gradually deprived of its oxygen, and would have organic impurity added to it, the air in the second would have its oxygen diminished and its carbonic acid gas and watery vapour increased, but would have organic matter destroyed, while the air of the third would become impure by the abstraction of oxygen, and the addition of carbonic acid gas, watery vapour, and animal exhalations. The animal living in the last-named atmosphere died first, that living in the air from which carbonic acid gas was removed died next, and that in the atmosphere from which the organic matter was separated out by the charcoal lived longest. The organic products of respiration, &c., are then not only those which give the stuffy fœtid odour to ill-ventilated rooms, halls, &c., but also those which are most injurious to health. The unaided nose, therefore, is well fitted to warn of danger.

An atmosphere might contain abundance of oxygen, but if the carbonic acid gas were greatly in excess, it would still be an atmosphere fatal to life, for the excess of carbonic acid gas in the atmosphere would prevent the same gas produced in the body from being given off, indeed the gas would pass inwards to the blood from the external atmosphere. In such a case death would result from poisoning by carbonic acid gas, the symptoms being those of a narcotic poison, no struggling, no gasping for breath, but unconsciousness deepening into coma. On the other hand an atmosphere might be cleared of excess of carbonic acid gas without new supplies of oxygen being furnished to it. If deficiency of oxygen became very marked death would again result, but not from narcotic poisoning by carbonic acid gas, but from want of oxygen. It is in this circumstance that the hurried laboured breathing, and violent convulsive spasms of suffocation occur.

The facts then of special practical importance are that an atmosphere containing a proportion of carbonic acid gas produced by respiration, and charged, therefore, with organic impurity, will become inimical to life, even when it still contains a good proportion of oxygen. Thus the candle, which goes out in the bell-jar, is extinguished not for want of oxygen, for the atmosphere in which it goes out contains still from 15 to 18 per cent of oxygen, but because of the presence of the carbonic acid. If any arrangements existed for withdrawing this latter gas, the candle would continue to burn for a longer period.

The practical question comes to be what amount of impurity due to respiration may exist in the atmosphere of confined spaces without injurious effects on health, at what degree of impurity does an atmosphere become hurtful? As soon as that question has been answered, one proceeds to inquire by what methods one may prevent the air of inclosed spaces reaching this degree of impurity.

A considerable number of experiments have been made to determine the first question. Thus Dr. Angus Smith had a leaden chamber made, air-tight, in which he could sit for varying times, and from which samples of air could be drawn off for analysis. Professor de Chaumont found, as the results of experiments made by him, that the sense of smell gave pretty accurate indications as to the degree of purity of the atmosphere. These results are expressed in the following table:—

Ordinary atmospheric air contains ·04 per cent CO_2.

When the air contains *an added*	·0183	per cent	it gives no perceptible smell.		
,, ,, ,,	·03894	,,	it smells	rather close.	
,, ,, ,,	·06322	,,	,,	close.	
,, ,, ,,	·08533	,,	,,	extremely close.	

If we add these quantities of carbonic acid gas produced by breathing to the quantity, ·04 per cent, already in the atmosphere, we find that when air contains ·06 per cent of CO_2 it is on the brink of becoming undesirable for breathing purposes; in round numbers when ·02 part CO_2 has been added to every 100 of the atmosphere by breathing, the limit has been reached for air that is to be considered pure. Now ·02 per cent is equal to ·2 per 1000 or 2 per 10,000. So if we express the above table in parts per 10,000, we shall have the following:—

Ordinary air contains 4 parts CO_2 in 10,000.

Air containing	6	,,	,,	does not perceptibly smell.
,, ,,	8	,,	,,	smells rather close.
,, ,,	10⅓	,,	,,	,, close.
,, ,,	12½	,,	,,	,, extremely close.

It must be remembered, however, that this only applies to air to which the added quantity of carbonic acid gas has been supplied by breathing. For the smell is not due to the carbonic acid gas; it is caused by the organic impurity also present in expired air. So that the quantity of organic impurity, which is detected by smell, is simply used as a rough index of the amount of CO_2 also present, both having been produced by the same process of respiration.

When the sensation of smell is taken as a gauge of the impurity, it must not be forgotten that one's sensation of smell is reliable for this purpose, only when one passes from fresh air into the confined space. Everyone is aware how very soon one gets accustomed to an atmosphere which seemed almost unbearable the moment one stepped into it. We often remain in a room or other confined space without being aware of the impurity which the atmosphere has attained. If we pass out from the room into the fresh air we are impressed with the pleasant freshness of the external air and involuntarily draw in deep drafts of it. If after a minute or two we pass back to the room, &c., which, in the meantime, we may suppose has been kept without any ventilation, we are at once conscious of the foulness of the air, we have been so long breathing without any consciousness of its impurity. Now it is not merely that we become accustomed to the atmosphere so far as our sensations are concerned, but the whole body adapts itself to the impure atmosphere. This has been easily proved in the case of the lower animals. Claude Bernard, the French physiologist, placed a sparrow in a bell-jar, which was inverted over mercury, so that no fresh air could enter. He found that it expired after three hours, before that time gradually becoming feebler and more languid till death occurred. If taken out at the end of the third hour it speedily recovered. But if an active sparrow were suddenly introduced, at the *end of the second hour*, into the jar, it died at once. That is to say the first sparrow could live a full hour longer in an atmosphere, to which it had become accustomed, and which was fatal to another sparrow suddenly introduced to it. The body can accommodate itself, if it has the opportunity, to a vitiated atmosphere to a certain extent; but this accommodation can be effected only by a depression of the bodily energies, by a lowering of the general vitality, which manifests itself in the languor, headache, listlessness, and lack of vigour so common to those who are accustomed to vitiated atmosphere for prolonged periods. A person of ordinary acuteness of smell may then judge accurately enough of the condition of the air of a confined space, provided he steps into it from fresh air, but the one who has been sitting in the vitiated atmosphere is least likely to be aware of its hurtful condition.

An atmosphere, then, to be considered of a healthy character, should not have more than ·2 part per 1000 of carbonic acid gas *produced by respiration*, or, as the phrase is, of respiratory impurity.

Quantity of fresh air required per head per hour.—Suppose one man to occupy a room 15 feet long, 10 feet broad, and 12 feet high. When empty this room would hold 1800 cubic feet of air. We shall suppose that with carpets, hangings, furniture and the man himself so much space was occupied that the quantity of air was only 1500 cubic feet. Suppose no air were to be able to enter or leave the room, we can easily calculate in what time the atmosphere would be polluted, by the breathing of the one man, to the limit we have named, 0·2 of a cubic foot of respiratory impurity to every 1000 cubic feet of air, that is 0·3 of a cubic foot to the 1500 cubic feet in the room. According to observations made by Pettenkofer, of Munich, an adult man produces in one hour 0·7 of a cubic foot of carbonic acid, when at rest; women produce less and children less also in proportion. Dr. Parkes and De Chaumont take 0·6 of a cubic foot as the fair average production by men, women, and children per head per hour. So that in half an hour, taking this average, the apartment named would contain 0·2 of respiratory impurity per 1000. At the end of an hour 0·6 of a cubic foot of respiratory impurity would be present in the 1500 cubic feet of air, that is 0·4 per 1000. It is clear that if this atmosphere is to be reduced to the limit of 0·2 per 1000, it would require to be diluted by an equal bulk of fresh air, it would require to be mixed with 1500 cubic feet of fresh air, and even then it would be on the verge of an improper degree of impurity.

To put it in another way, at the beginning of the hour the man enters the chamber containing 1500 cubic feet of fresh air, suppose that there is a current of fresh air passing through the room just sufficient to renew the whole air of the room once in the hour, that is to say, during the hour, 1500 cubic feet of air pass through the room. Then at the close of the hour the atmosphere will contain 0·2 of respiratory impurity per 1000. Suppose the man remains in the room; he starts the second hour with 0·2 per 1000 of respiratory impurity already present, that is 0·3 of a cubic foot in his 1500 cubic feet of air; he produces during the hour 0·6 of a cubic foot of respiratory impurity, which, added to what was present at the beginning of the hour, makes 0·9 of a cubic foot of respiratory impurity. To reduce this 0·9 to 0·2 per 1000, 4500 cubic feet of air would be needed. But the apartment contains only 1500 cubic feet. So that if the atmosphere of the chamber is to be kept down to the proper limit, it will be necessary that during the second hour 3000 cubic feet of fresh air enter it. If a current of fresh air equal to this amount has passed through the room during the second hour, then at the end of it the respiratory impurity will be still at the limit of 0·2 per 1000. Suppose the man remains another hour, the conditions are the same as during the second, so that after the first hour he needs a supply of fresh air equal to 3000 cubic feet per hour. Whatever the size of the room one takes to begin with, it will be found on calculation, supposing the average production of carbonic acid gas to be 0·6 of a cubic foot per head per hour, and the respiratory impurity to be limited to 0·2 per 1000, that 3000 cubic feet of fresh air are required per head per hour. This calculation, it is to be observed, is made for persons at rest. De Chaumont says: "Of course in rooms occupied by persons in active work, more would be required, as from 50 to 100 per cent more impurity would be evolved; therefore, in ordinary workrooms, from 4000 to 5000 cubic feet per head per hour would be necessary, and in unhealthy trades 6000 to 7000. Some of my experiments were made in hospitals, occupied for the most part by ordinary cases, and I was thus enabled to compare the results with those in barracks occupied by healthy men. . . . It took nearly *one-third* more air to keep the atmosphere sweet in hospitals, so that we may safely lay it down that in ordinary cases no hospital ward ought to have less than 4000 cubic feet per head per hour, and that in cases . . . of epidemic disease the amount ought to be greatly increased; indeed practically the amount ought to be unlimited, so that many kinds of disease might be advantageously treated in the open air. This is proved by the great success of tent hospitals, both in time of war and in time of peace. In Germany this open-air plan has been practically tried to a great extent, and with very gratifying success."

De Chaumont gives a table, which I give here, to show the length of time it would take to bring the air in unventilated spaces of different sizes to the limit of purity (0·2 of a cubic foot of respiratory impurity per 1000 cubic feet of air):—

No. of Persons.	Size of Space in cubic feet.	Time taken to bring Air to Limit of Purity.		
		hours.	minutes.	
One man	......10,000	3	20	
,, ,, ...	5,000	1	40	
,, ,, ...	1,000		20	
,, ,, ...	600		12	
,, ,, ...	200		4	
,, ,, ...	50		1	
,, ,, ...	30			36 seconds.

The following table, showing the quantity of impurity per 1000 cubic feet of air produced by one man in inclosed spaces of different sizes, and the quantity of fresh air needed per hour to dilute the impurity to the standard limit, is derived from Parkes:—

Quantity of Air Space in cubic feet.	Quantity of CO_2, produced by Breathing, per 1000 cubic feet of Air per hour.	Amount of Fresh Air needed during the First Hour to dilute CO_2 to 0·2 per 1000.	Amount of Fresh Air needed to dilute CO_2 for every Hour after the first.
100	6·00	2900	3000
200	3·00	2800	3000
300	2·00	2700	3000
400	1·50	2600	3000
500	1·20	2500	3000
600	1·00	2400	3000
700	0·85	2300	3000
800	0·75	2200	3000
900	0·66	2100	3000
1000	0·60	2000	3000

Effects on air of the burning of candles, gas, &c.—The calculations that have been made have permitted no allowance for the burning of fires, candles, oil-lamps, or gas; and as these cannot burn without their due supply of oxygen, a considerable increase in the amount of fresh air will be necessary. Thus it has been calculated that one sperm or paraffin candle will produce in one hour half the quantity of carbonic acid gas produced by a man at the same time, so that two candles will necessitate an hourly supply equal to that for one man. A good oil-lamp produces rather more than ½ cubic foot of carbonic acid gas per hour—that is about the amount produced by one man, and a good gas-burner (which burns 3 cubic feet of gas per hour) will produce 6 cubic feet of carbonic acid gas per hour. Therefore one man and one good oil-lamp will together produce in one hour nearly 1·2 cubic feet of carbonic acid gas. To bring this down to the proper limit 6000 cubic feet of fresh air would be required per hour, no matter what were the size of the space. Calculating on the same basis, one man and one gas-burner would produce 6·6 cubic feet of carbonic acid gas per hour, necessitating 33,000 cubic feet of fresh air per hour. This is an enormous quantity; and it must be remembered that the burning gas, while it yields much more carbonic acid gas than a man breathing, does not yield organic impurity, so that the necessity of diluting it to the same extent as respired air is not nearly so urgent. It has been thought that 1800 cubic feet of air per hour would be necessary for each cubic foot of gas burned. If 3 cubic feet per hour are burned, that implies 5400 cubic feet of fresh air for that purpose alone, which, added to the 3000 necessary for the man, amounts to 8400 cubic feet per hour for one man with one gas flame burning.

One pound of oil requires about the same amount of fresh air as 10 feet of gas. If the same amount of light is yielded by each, gas, oil-lamps, and candles render the air impure nearly to the same extent, so that there is not much to choose between them. As a matter of fact it appears that gas gives more illuminating power with a smaller consumption of atmospheric air than wax candles. But when lamps or candles are used, they are usually so placed as to throw the light in a particular direction, where the illumination is desired. The necessary illumination is obtained at a much less consumption of material, and the air suffers much less in consequence, not only because of a diminished production of carbonic acid gas but also because of a lessened amount of heat and moisture.

Another point, which requires consideration in the question of the quantity of fresh air to be supplied per hour, is the burning of fires. A fire in an ordinary fireplace, in a room 20 feet long by 20 broad by 12 high, is assumed to burn 8 lbs. of coal per hour. For proper combustion this coal requires 1280 cubic feet of air. It is to be noted, however, that the draught up the chimney created by the burning coal causes a current of air to the fire much greater than is necessary for the consumption of the coal. Probably twice the quantity of air, needed for combustion, is carried up the chimney; and 14,000 to 20,000 cubic feet of air is considered a moderate computation of the amount that will pass up the chimney of such a fire in one hour. In the burning fire, therefore, there is a powerful agent in the renewal of the air in an apartment.

Moisture of the Air.—Another factor enters into the calculation of the quantity of fresh air needed per hour in inclosed spaces, and that is the quantity of moisture the air contains. Watery vapour, it has been stated, is contained in fresh air in proportion to the warmth of the air. Air as it is breathed out from the body is saturated with watery vapour, and we know that if the air be breathed on a sheet of cold glass, the vapour will be deposited in the form of minute drops of water. Moreover watery vapour is constantly being given off from the body in the form of perspiration, usually invisible perspiration. The importance of this in regulating the temperature of the body has been referred to on p. 309. If the air surrounding a person be dry, that air can absorb moisture to a large extent, to a greater extent in proportion to the warmth of the air. If, on the other hand, the air is already saturated with moisture it cannot absorb more, evaporation cannot take place from the body, and the moisture will be readily deposited on the body itself. If the external atmosphere is cold this deposit of moisture will have the effect of rapidly cooling the body, because water is a better conductor of heat than air, and the thin film of water on the body will cause the body rapidly to part with its heat to the cold atmosphere, resulting in chilling. If the external atmosphere is warm and saturated with moisture, the body cannot part with its heat properly, and a feeling of oppressive sultriness and languor is produced. Now in a confined space, owing to the watery vapour given off from the lungs and from the skin, the air will by and by become saturated with watery vapour, and discomfort will be occasioned. This will happen sooner or later according to the size of the space. Therefore to prevent saturation occurring a fresh supply of air is needed. The burning of lights produces also watery vapour, and if any liquids be in the inclosed space, vapour will pass off from them, saturating the air more rapidly than if only the evaporation from the body of a person were occurring.

The degree of moisture in the atmosphere which is most comfortable to the body has been determined to be 75 per cent, complete saturation being assumed to be 100. The actual quantity of vapour in the atmosphere, sufficient to produce this degree of moisture will, of course, vary with the heat of the atmosphere. Thus at a temperature of 63° Fahr., 4·7 grains of water per cubic foot of air produce this degree, and at a temperature of 65° Fahr., 5 grains. That is to say the higher the temperature of the air the more moisture it can hold, without exceeding the degree (75 per cent) most agreeable to health.

Now it has been calculated that an adult man will raise the degree of moisture in a space, containing 500 cubic feet of air at 60° Fahr., from 70 per cent to saturation in one hour, and with a space of 1000 cubic feet, occupied by one person, 3000 cubic feet of fresh air per hour would be necessary to maintain the degree of moisture at the proper level.

In short we have found that, if the air of an inclosed space is to be kept at a proper standard of purity, as regards the quantity of carbonic acid gas produced by respiration, 3000 *cubic feet of fresh air per hour, for every individual present, ought to be supplied, and that this same quantity of fresh air will keep the air of the apartment at a proper degree of moisture; and further we have found that, for every cubic foot of gas burned, an added* 1800 *cubic feet of air are necessary, while a fire needs a large additional quantity.*

The question, therefore, is now how can this large quantity of air be duly supplied without perceptible currents being produced, that is to say, without draughts?

For what does 3000 cubic feet of air per hour imply? It means that suppose a room affording only 500 cubic feet of air space, the whole air of the room must be renewed six times each hour, and if two persons occupy the room, the air requires renewal twelve times per hour. This could not be borne. If the room had 1000 cubic feet of air space, then the air needs renewal only three times per hour for one person, but six times for two. On the other hand a room having 3000 cubic feet of air space (and a room 15 × 18 × 13 would have that, even allowing 500 cubic feet of space for furniture) would require renewal only once during the hour for one person, twice for two, thrice for three and so on. Renewal four times during the hour is the most that can be borne in a climate such as ours, where it is scarcely possible at any season to have the house freely open to the external air. It is, therefore, readily seen that the problem of ventilation is a very difficult one when one is dealing with small inclosed spaces, and also very intricate when one is dealing with halls, lecture-rooms, school class-rooms, &c. For in the small space the air must be renewed often, yet without draughts, and in the halls, &c., one expects large numbers of persons, and must again provide for frequent renewal of air. The problem, on the other hand, is simplified when one is dealing with, for example, a modern house, of large rooms with lofty ceilings, spacious hall, and so forth, in ordinary circumstances perhaps occupied by only six or eight persons at a time. But if on the occasion, let us say, of an evening party, the rooms are crowded with guests and many lights are burning, the difficulty of fresh air at once arises. It remains then to be seen how, in ordinary circumstances, these difficulties are met.

It is not, it must be observed, that a person living in a large space needs less fresh air than a person living in a small space, they both need the same, namely 3000 cubic feet per hour, but it is that this 3000 cubic feet of air can be so introduced and distributed in the large space that its entrance is not observed, while in the small space it is very difficult without elaborate arrangements to introduce the needful quantity without the establishment of unpleasant currents. High ceilings are, therefore, desirable, for it has been found that, if the height is less than 10 feet, currents of the circulating air are certain to be perceptible to a disagreeable extent. As regards floor space, it is desirable that the minimum should not fall below 50 to 60 square feet, per person, if possible not below 80 square feet. Taking 60 square feet and allowing the height of the room to be a minimum of 10 feet, that would allow 600 cubic feet of air space for each individual. This is the space allowed in barracks for each soldier, but 200 only is allowed in a cell of Chatham Convict Prison. If we take 600 as a standard, a room 10 × 12 and 10 feet high would contain 1200 cubic feet of air, and this should not contain more than two persons. One can, therefore, easily calculate the number of persons, inhabiting one room, that will be consistent with a fair standard of purity of air, by simply multiplying the length of the room by the breadth and the result by the height and dividing by 600. It will be noticed that to provide 3000 cubic feet of air per hour for one person in such a space, implies renewing the air of such a space five times per hour, implying careful arrangements for proper ventilation.

Methods of Ventilation.

Methods of ventilation are divided into natural and artificial. The artificial include those means adopted in large establishments, halls or churches, by which by means of some pumping or suction apparatus air is driven or drawn through the building. The natural methods are those which depend upon the ordinary physical laws, which everywhere regulate the movements of air and wind. It is not the object of this work to consider the artificial methods, always requiring elaborate machinery, but to point out the principles that should guide the arrangements for securing natural ventilation, and the main simple contrivances employed for that purpose.

Ventilation through Walls.—A quite unsuspected means of natural ventilation has been pointed out by Pettenkofer of Munich, who showed and proved by an interesting experiment that air readily passed through the walls of a house, so that an exchange of air was effected between the atmosphere within and that without the house. This is effected by the physical process called diffusion of gases, already referred to on p. 258. Two gases will mix if placed in contact with one another, and they will also mix though divided from one another by a membranous partition, and they will mix with great facility through a partition of baked clay or other porous substance. It is in accordance with the same physical law that when there is the atmosphere of a confined space, the air of a room, separated by a wall—a porous partition—from the outside atmosphere, exchange and mixture should be effected through the wall. Such exchange will take place much more rapidly if the two atmospheres are at different temperatures, as they almost invariably are, the air of the room being warmer than that of the outside. Thus Pettenkofer found in the case of a room with brick walls, in which every crevice and crack had been carefully closed, and which contained about 2700 cubic feet of air, that the whole air of the room was completely renewed once in an hour by diffusion through the walls, when there existed a difference of temperature equal to 34·2° between the inside and outside air. When the difference of temperature fell to only 7° Fahr. the change of air fell to 780 cubic feet per hour, and with the same difference the change was increased to only 1060 cubic feet when a window 8 feet square was opened. This exchange through walls was illustrated by Pettenkofer in a very striking way by the blowing out of a candle through a 9-inch brick wall. If a brick be covered all over except at the two ends with a coating of wax, or other impervious material, and if then at each end there be fixed a small funnel, the junction of the two being also covered with wax, and if a lighted candle be placed near the opening of one funnel, and the person blow into the other funnel at the end of the brick, the candle flame will readily be made to flicker, and after a little with an effort may be blown out. By surrounding a piece of wall with an air-tight box and otherwise making an arrangement similar to that described with one brick, though on a large scale, the candle may still be blown out. It has been found by two German observers that with a difference of temperature of 4° Fahr. air passed, by this natural process of diffusion, through one square yard of wall, at different rates according to the nature of the material of which the wall was built, as the following table shows:—

1 Square Yard of Wall built of	Cubic Feet of Air per Hour passing.
Sandstone	4·7
Quarried limestone	6·5
Brick	7·9
Tufaceous limestone	10·1
Mud	15·4

It is clear then that the ventilation of a house will to a considerable extent be affected by the material of which it is built. A brick-and-mortar building is very pervious to air, so also is sandstone. Cement walls on the other hand are much less porous, and it is questionable whether they make a healthy house. If they are impervious to water from without, they are equally impervious to water from within. The watery vapour, given off by breathing which would be to some extent absorbed by the porous wall, is not absorbed by the impervious one, but the moisture deposits on the colder wall, collects and runs down and makes a very unpleasant house.

The permeability of the walls will also be affected by papering, painting, and varnishing. "Coating with water-glass," says Lang, "probably in time completely destroys the permeability of a wall, so also does oil-paint, while new, although the cracks which come in the course of time make a considerable difference. When I state that oil-paint is the principal agent in preventing the diffusion and passage through the walls of the watery vapours which originate in domestic processes and respiration, it will be necessary for the science of hygiene to decide whether water-glass and oil-paint will have to be condemned. Size-colours also lessen the permeability considerably, and in proportion to the strength of the size; that used by me was so feebly sized that it lost colour, and yet the amount of air passing through was lessened by one-half; the smallest loss of permeability occurred when lime-colours were used."

In the next place it is also plain that a house with several free walls will be more easily ventilated in this way than one with less. A detached villa, for example, will permit of this diffusion taking place from all sides.

Then it will be noticed that this natural means of ventilation will come most prominently into force during the colder periods of the year, just at those periods when one seeks to close up, in a wholesale fashion, all ways for the entrance of cold air from the outside and to heat up the interior. The great difference thus produced between the temperatures within and without will develop the diffusion to its greatest amount. A remarkable case in a London house is related by Mr. W. N. Hartley of King's College, London, "which gives a distinct proof of the much greater passage of gas through the walls in winter than summer. A small room occasionally used was noticed sometimes to have an unbearably bad smell; this was never noticed in summer, nor in winter unless a fire was lighted in the room; the drainage was suspected and examined, but was found perfect, yet here was this extraordinarily foul air making its way into the room, whenever the interior was warm and the exterior was cold. The cause was a dust-bin built against one of the walls, and the filtration [diffusion] of the air through this and the house wall into the room."

This natural means of ventilation is in every way desirable, since it permits an exchange of air quite free from draught, and since the passage of the air through the wall robs it of solid impurities. At the same time if walls are porous to air they are also porous to water, and while it is desirable to build them of material that will not interfere with a valuable means of ventilation, it is also necessary so to build them as to afford adequate protection from the weather. Moreover walls permeated with moisture deny a passage to air. Again walls whose pores are occupied by air are bad conductors of heat, air being a very bad conductor, and thus such walls do not readily conduct the heat from the dwelling. On the other hand water is a good conductor of heat, and if the walls are saturated with water, they become good conductors and are very active in reducing the temperature of the house. It is for this reason that houses with damp walls give one so marked a sensation of chilliness. The porosity of walls is, therefore, largely retained and the disadvantages of their being penetrated with water largely reduced by thickness. In a wet climate a thick wall will prevent the access of damp and the loss of heat, and in hot climates it will hinder the heating up of the house by the rays of the sun, under both circumstances assisting in the maintenance of a mean temperature. Double walls would answer the purpose admirably, the two walls being separated by a space of 1½ to 3 inches, and bound together at proper intervals. The passage of damp would be prevented, the layer of air would be an admirable non-conductor, and exchanges between the outer and inner atmospheres would not be interfered with. For exactly similar reasons walls should be lathed before plastering, the plaster, being by the lathing separated from the wall, acts as an inner wall, an air-space existing between the two. Walls plastered without previously being lathed are usually damp.

Not only does exchange of air take place between the outside and inside of a building but it takes place also by the same natural processes between the various portions of a building. The atmosphere of a room is, therefore, affected not only by diffusion between it and the air outside through the walls but also by diffusion through its floor and ceiling between apartments above and below. We all know how an escape of gas in one room is detectable in a room above. This is of special importance in houses provided with cellars, which are so often allowed to lie in a state of dirt and disorder and with no proper means of ventilation. If the cellars are underground, as they so often are, this becomes a matter of very serious importance, demanding careful attention.

Further there is retained by the soil a large quantity of ordinary air and other gases, and the very reasons which should induce one not to interfere with the natural ventilation occurring between the free air of the outside and the air of inhabited houses, would cause one to take steps to prevent exchange of air between the atmosphere of a house and that of the soil on which it is built. This is specially the case, if the ground is a made-up one, which may contain all sorts of refuse, decaying animal and vegetable matter, and effluvia from drains, &c. Such exchange is prevented by the house being provided with a foundation of cement and by a layer of damp-proof material, in the wall above the level of the ground, which adjoins the wall. Slates of glazed earthenware, slates embedded in cement, in asphalt, &c., are used to provide such a "damp-proof course" as it is called, which with the layers of cement ensures both against the passage of soil-air into the house and the rising of damp.

Still further to prevent gases from the soil entering the house, it is well to ventilate the space between the foundations and the basement floor by means of gratings let into the walls. The need of such precautions is abundantly shown by the fact stated by Pettenkofer, that persons were poisoned in a house by coal-gas, though no coal-gas was laid on to the house. The gas had escaped into the soil at a distance from the house, had travelled 20 feet under the street, and had thus gained access to the foundations and cellars of the house. A case occurred near London in 1874, where coal-gas gained entrance to houses by permeating the soil, the gas coming from a damaged main. It accumulated to such quantity that finally an explosion occurred which demolished one of the houses.

Openings for Ventilation.—We have thus considered the natural exchange that goes on between the warm air of a room and the colder air of the outside, and we have seen that it may be a valuable means of ventilation; what other means usually exist? It is very commonly the case that there is no special provision whatever for the letting in of fresh air, or the letting out of foul air, beyond what can be effected by the opening of a door or window. If a fire is burning it ensures the passing of a current of air through the room. The fresh air enters by every available crack and crevice or ill-fitting joint, under the door, through the key-hole, and by the sides of the window. A sufficiently plentiful supply may gain admission, but it is in an undesirable way, cold currents being produced, and it is in a way not under control. Moreover, with the entry of the air is the entrance of dust, and indeed the direction of the current along a wall, &c., is frequently shown by the dust-track. Now if a sufficiently large opening, communicating with the outside, be made to permit the free entrance of the necessary supply of air, all these irregular air currents will be abolished, and the flow along the open channel can be regulated at pleasure, while various filter arrangements can be employed against dust. Let anyone hold a candle flame opposite the keyhole of the door, in a room which has no special inlet for air, the deviation of the flame will show a strong current. Now let a window be raised slightly to permit free entrance of air, the behaviour of the candle-flame will show that the current through the keyhole has ceased. It is, therefore, desirable that special openings should be made, certainly for the inlet of fresh air, and also for the outlet of foul air, even though a fire acts admirably as an extractor of air.

What, then, are the general principles that should guide one as to the position, size, shape, &c., of these inlet and outlet openings?

The position of air openings is regulated by the fact that heated air rises. The foulest air in a room is nearest the roof, and this in spite of the fact that the foul air contains a considerable proportion of carbonic acid gas, which is a heavy gas, heavier than ordinary air. It is only its greater degree of warmth, as it is expired through the mouth, that causes the polluted air of respiration to ascend. If this foul air, after ascending towards the roof, became cooled, the carbonic acid would descend and would more readily have the opportunity of being breathed over again. The outlet for foul air should then be placed as near the roof as possible. If it were possible, so far as comfort is concerned, to admit the fresh air by an opening near the floor, it would be a natural arrangement. The cold air would enter below, the foul heated air would escape above. But this is not a suitable arrangement, as it would tend to cause chilling of the feet of the occupants of the room. For similar reasons it is undesirable that fresh air should enter at any level which would render it possible for it to strike against any part of the body of a person in the room, and, therefore, it is customary to arrange the inlet opening so that the fresh air enters above the level of persons standing in the room, and to direct it towards the roof, so that it spreads out and is diffused through the apartment.

Inlet Ventilators.—If the chimney is deemed a sufficient means of withdrawing the foul air, then only an inlet tube needs to be provided. It may be placed in the wall near to the ceiling, and it should be so arranged as to direct the current of entering air towards the roof, against which it strikes and is so broken up into a fine shower of fresh air, draughts being thus prevented.

Window Ventilation.—The simple contrivance of having holes cut in one of the topmost panes of a window, which may be opened or closed by a revolving glass disc, on the hit-and-miss principle, is good enough so far as the admission of air is concerned, but it admits direct currents and so occasions draughts. Of window-pane ventilators a better form is that with louvred panes, by means of which the air is directed upwards. Another simple contrivance is to have a slit made in the lower bar of the upper half of the window, running the whole length of the bar, so as to leave a space about a quarter of an inch at the place where the upper bar of the lower sash and the lower bar of the upper sash meet. This permits of an entering current and directs it upwards. Another method is to fit a bar of wood, about three inches broad or thereby, to the bottom of the lower sash of the window, so that the lower sash is kept raised a couple of inches or so, and yet no air permitted to enter below. The effect of this is that the two sashes do not meet in the middle, as they do when the window is completely shut, and air is thus permitted to enter in an upward stream. If a room is fitted with double windows, ventilation is very easily carried out by keeping the lower sash of the outer window open a few inches, and the upper sash of the inner window down a few inches. The air entering at the bottom of the outer window passes up in the space between the two windows, and enters the room above. This arrangement has a double advantage. The single window is the cause of a great loss of heat to the room. Thus, suppose a room of ordinary size, containing 3000 cubic feet of air, and having two windows with a surface of glass equal to 30 feet. One square foot of glass, it is said, will cool 1·279 cubic feet of air as many degrees per minute as the internal air exceeds the external in temperature. If such a room is occupied by six persons, its air will require renewal four times per hour at least, and the total cooling effect of the glass will, in these circumstances, be such as to represent a constant lowering of temperature of the air in the room equal to 9·5°. Now if the windows be double much of this loss of heat will be prevented, the outer panes preventing the inner being constantly robbed of their heat by the cold external air. Moreover, the entering air, as it passes through the space between the two windows before gaining the room, will be somewhat warmed by contact with the inner panes, and thus the double benefit will be gained. It is always, however, preferable, except where double windows exist, to have a special inlet for fresh air, altogether separate from the window.

The Sheringham ventilator (Fig. 270) is a simple yet cheap and effective apparatus for this purpose. It is an iron box fitted into the wall, near to the ceiling, and communicating directly with the external air. It is provided on the inside with a hopper valve, which may be altogether closed or opened to any desired extent by means of a cord working over pulleys. The valve opens in such a way as to direct the current of air to the roof. The inner opening is larger than the outer, so that the rapidity of the current of air at the outer opening is diminished at the room opening, and the current is spread out as it enters the room. One other advantage of this form of ventilator is that in the event of both outlet and inlet openings being provided, it may become an outlet opening, permitting the escape of heated air from the upper part of the room, if fresh air is entering by other channels; and if these other channels are closed, it may again become an inlet opening.

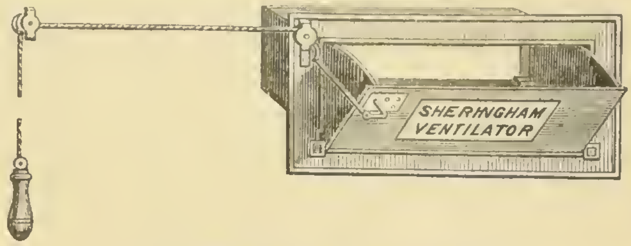

Fig. 270.—Sheringham Patent Ventilator.

Mr. Pridgin Teale, the surgeon, of Leeds, ventilates his room by means of an opening in the wall near the ceiling, 5 feet by 16, in which is fitted a broad tube. Within this tube is a canvas screen placed diagonally, so that the air is filtered as it passes through, while at the same time the current is slowed and broken up. On the room side he has a Harding's diffuser, an arrangement for spreading out the current into a multitude of tiny streams. The inner opening is also fitted with a door permitting the ventilator to be opened or closed at pleasure. He finds, however, that the arrangement works so well, that it is allowed to remain constantly open, winter and summer.

Another form of inlet ventilator is shown in Fig. 271. It also is fitted into the wall near the ceiling, and communicates directly with the outside air. A diagram of the arrangement is shown in Fig. 272. At *a* is the opening on the outside by which the air enters; a shield *b* causes the air to be deflected downwards to pass over a trough of water *c* by which the air is cooled, and by which also the air is deprived of a large amount of its solid impurity. The air is then directed upwards towards the ceiling

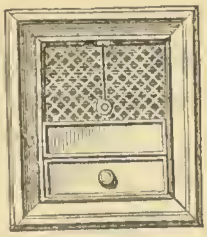

Fig. 271.—Air Inlet Wall Panel.

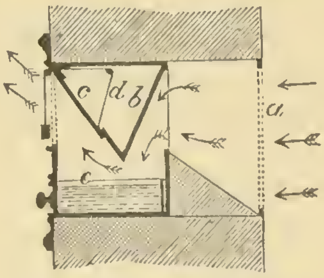

Fig. 272.—Section of Air Inlet Wall Panel.

by the bar in front of the lower part of the inner opening. The valve *c d* is capable of being raised or lowered to regulate the current of air, and the perforated front breaks up the current and diminishes its velocity as it enters the room. Such air-inlet panels may be obtained in many forms, but are all on the same principle. The trough of water may be dispensed with, or it may be filled with some disinfectant, or a filter of gauze may be substituted. A feature of Sheringham's and such ventilators is the ease with which they may be kept clean, a very important matter.

Tobin's Inlet Tubes.—Another method of introducing fresh air is by means of tubes, of a style with which the name of Mr. Tobin, of Leeds, is usually associated. They open directly through the wall on a level with the floor. The tube then rises against the wall to a height above the level of the heads of persons in the room. A regulator is placed in the tube, the handle of which projects at the side, by means of which the tube can be closed against the current or opened to a greater or less extent. At the opening a projecting lip directs the current upwards and from the wall. In such tubes there is usually a funnel-shaped canvas bag, or similar contrivance, for the purpose of filtering the air. Fig. 273 shows a similar contrivance, in the form of a wall bracket, and Fig. 274 represents it in section. D is the opening in the wall supplied with an outside grating. B is the regulator, A the filter, and C the projecting lip. This bracket would open through the wall above the level of the heads of the inmates of the room. In the case of a tube rising like a pillar or panel in the wall, D would be at the floor line, and the tube would rise inside against the wall as already indicated. These tubes may be made of any ornamental design, as wall pillars, wall panels, wall brackets, &c., so that their real purpose is not apparent, as is evident from Fig. 275. In churches, halls, and very large rooms, pillars supporting beams, galleries, &c., could be utilized for such purposes, the inlet being at the capitals. The difficulty of cleaning such tubes is one of their main disadvantages.

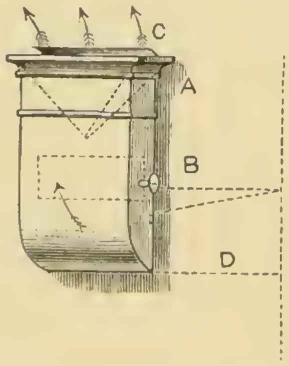

Fig. 273.—Wall Bracket Inlet on Tobin's System.

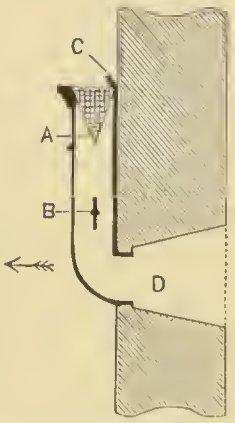

Fig. 274.—Section of Wall Bracket Inlet.

One of these tubes might be employed as an inlet ventilator, and near the ceiling on the opposite wall, a Sheringham or other similar ventilator might be used as an outlet ventilator for foul air.

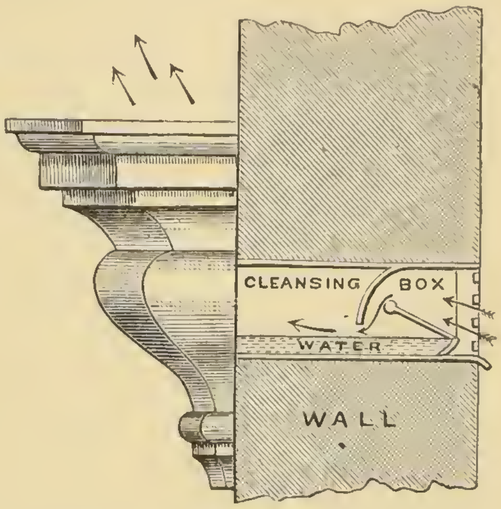

Fig. 275.—Ornamental Wall Bracket Inlet Ventilator, with Arrangement for Purifying the Entering Air.

Outlet Ventilators.—One situation in which a ventilator for the escape of foul air is frequently placed is in the wall above the fireplace, not far below the cornice. It opens into the chimney, the upward draught causing the ventilator to act. The disadvantage of such a situation is that in the event of a down draught, such as produces back-smoke, smoke from the chimney would be driven through the ventilator into the room. To prevent this, such ventilators are usually supplied with valves of very light material, preferably mica, which close on the slightest stoppage of the upward current.

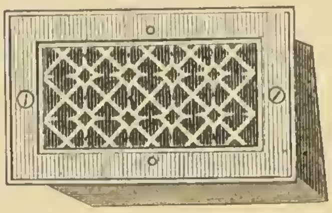
Fig. 276.—Mica-flap Outlet Ventilator (front view).

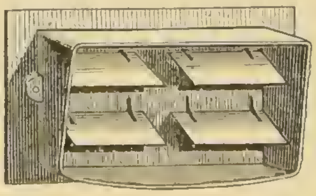
Fig. 277.—Mica-flap Outlet Ventilator (back view).

Fig. 276 gives a front view of such a mica-flap ventilator, and Fig. 277 shows the back view, in which the flaps are seen.

Shaft Ventilators.—In other systems ventilating shafts are used, opening from the ceiling of the space to be ventilated and passing up above the top of the building, such as is diagrammatically represented in Fig. 278. This is the method adopted for large institutions, military hospitals, barracks, &c. When an efficient inlet is also provided difficulties are reduced.

But when there are no special inlets the movements of air in the shafts are much disturbed by the influence of winds, changes of temperature, and so on, which indeed create difficulties in every system. But in single shafts there is a tendency to a double current interfering with proper ventilation, one of fresh air passing down and another of foul air escaping, dependent among other circumstances upon the temperature of the space being ventilated, and therefore on the number of persons present in it, and also on the temperature of the shaft.

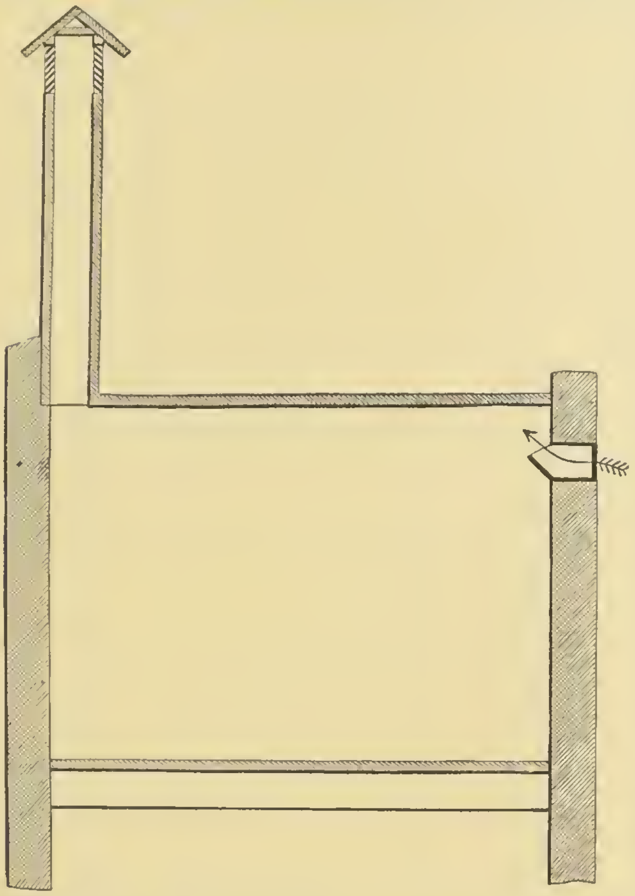

Fig. 278.—Shaft Outlet Ventilator and Sheringham's Inlet Valve.

Watson showed that if a partition completely divides such a shaft into two, a current of fresh air passes down one side and a current of foul air up the other. On this principle M'Kinnell's ventilating shaft is constructed. It consists of two circular tubes, one within the other (Fig. 279), both opening at the ceiling. The inner one rises to a greater height than the outer, and is the outlet tube. The outer or inlet tube is provided with a flange, a little below the ceiling, which directs the entering air along the ceiling and prevents it being poured down on the heads of the inmates of the room or hall. The entering air is somewhat warmed by contact with the inner tube, heated by the escaping foul air. Such shafts need a hood to prevent the descent of rain, and may be provided with cowls turning away from the wind. In such cases the cowl is most efficient when large, with wide projecting mouth.

Shaft systems of ventilation are now usually provided with some arrangement at the head, by means of which the wind may be utilized to exert a suction action for the extraction of the foul air. There are numerous ventilators, designed for such a purpose, in the market. Similar ventilators are sometimes fitted on the roof opening of soil-pipes for the extraction of foul air in the pipe.

The size of the ventilating openings requires to be taken into consideration, and is regulated by the speed which it is desirable the current should possess and the quantity of fresh air to be supplied. This latter, as we have seen, depends upon the number of persons in the space to be ventilated, the number of lights burning, and so on. The production of a movement of air is the result of a difference of temperature. Warm air expands and becomes, therefore, specifically lighter. It therefore rises and is displaced by a volume of cold air flowing in to take its place. The velocity of a current in a chimney or ventilating shaft may be calculated by ascertaining the difference of temperature between the heated and the external air and the height of the chimney. The size of the openings necessary to give a desirable rapidity of current can be calculated out by such data; but as the rapidity will vary with the temperature, so a given size will suit only a definite range of temperature, and therefore the necessity of some means of regulating the size of the opening. The velocity of current at the point of entry of fresh air ought not to exceed, according to De Chaumont, 5 feet per second, and to secure this, "48 square inches of total inlet and outlet area ought to be provided, and this independent of the chimney, if there be an open fireplace." Dr. Parkes says: "It is impossible to fix any size which shall

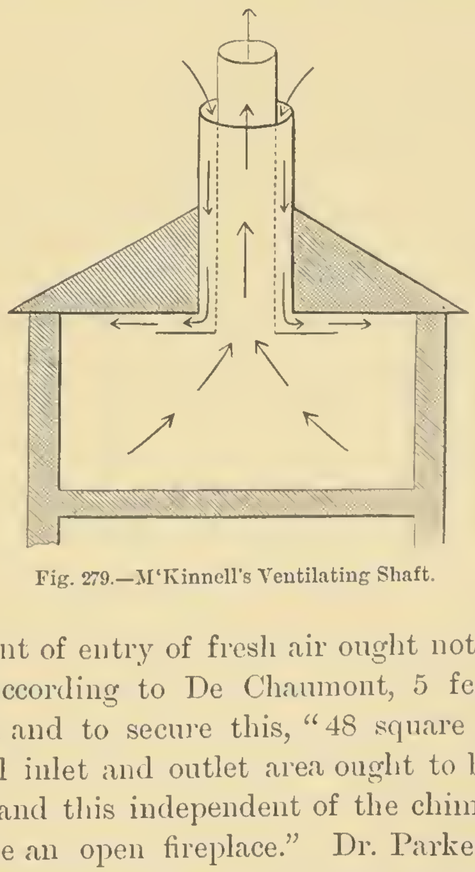

Fig. 279.—M'Kinnell's Ventilating Shaft.

meet all conditions, even if the influence of wind could be completely excluded, which is impossible. The only way is to adopt a size which will meet most cases, and supply means of altering the size according to circumstances. In this country, a size of 24 square inches per head for inlet, and the same for outlet, seems calculated to meet common conditions; but arrangements should be made for enabling this to be lessened or closed in very cold weather, or if the influence of strong winds is too much felt. Moreover, the size must be in part dependent on the size of the room, because in a small room with many people it is impossible to have the size so great as it would be if each person's space were 48 square inches, unless some portion of the air were warmed. . . . It is desirable to make each individual inlet opening not larger than 48 to 60 square inches in area, or enough for two or three men; and to make the outlet not more than one square foot, or enough for six men. Distribution is more certain with these small openings. It must, however, be borne in mind, that if a calculation is made for a single opening of a certain size, dividing it into a number of smaller openings causes a great loss by increasing the friction. . . . Inlets should not be large and single, but rather numerous and small (from 48 to 60 inches superficial), so that the air may be properly distributed. . . . If there be several they should be, of course, equally distributed through the room, so as to ensure proper mixing of the air."

Ventilation by Chimneys.—It will not be out of place here to note a few practical facts which have been observed regarding the draught produced by chimneys, the chief means of ventilation in many houses. The movement of the air in flues is determined by the differences of temperature of the inside and outside air, as already indicated, and by the length of the flue. Many circumstances, determined by the construction of the chimney, affect the current in it. The movement of the air is retarded by friction against the walls, and, therefore, the more smooth the inner surface is the better will be the draught. Sudden bends, by increasing the friction, diminish the draught. Again, variations in the diameter affect the rapidity of the current, increased diameter slowing it and contractions increasing its speed. Sudden changes in diameter are inadvisable, and whatever change is necessary should be effected gradually, a sudden enlargement having a specially retarding influence on the current by the eddies it creates. A gradual narrowing at the top is quite common and increases the rapidity of the current, while it tends to prevent the descent of cold air; and the throat, or part leading to the fireplace, is also made narrow to aid the velocity there, and prevent the occurrence of a back-draught as well as the escape of unwarmed air into the shaft. Then if several flues enter the one shaft, their direction must be studied. For two currents may meet one another in such a way as almost to destroy the velocity of outflow, and thus make the chimney smoke. All additional flues should, therefore, be made to enter the main shaft as nearly as possible in a vertical direction to prevent such a result. The upper current is also better maintained if the main shaft is somewhat narrowed just below the point of entrance of the additional flue.

A bad draught may be caused by some of the errors in construction indicated. Too wide a flue will occasion it by permitting a current of such diminished velocity that the smoke and air has time to cool, doing away with the difference of temperature which is the cause of any current at all. By permitting the entrance of a large body of unwarmed air, the same effect is produced. A funnel, square in cross section or of the shape of a parallelogram, tends to permit this cooling action to occur; a funnel, circular in section, is best, and in diameter it need not exceed eight inches. If the supply of air to the fire is too little, as it will be when the room is provided with no inlet for fresh air, and when doors and windows are very tight, a bad draught is certain to exist, the remedy for which would be a Sheringham or other form of inlet ventilator. In summer, when no fire is burning in the fireplace, and when the atmosphere of the room is cooler than that of the outside air, the reverse of the ordinary conditions is established and a down-draught is certain. This can be prevented only by valves.

Such faults may be remedied by some form of cap, which makes use of the movement of the wind to produce a suction action, as in the case of Boyle's ventilator or some of the many forms of cowl which move with the wind. A cap is also a protection against the entrance of rain, and against the wind producing a down-draught.

WARMING.

The necessity for the entrance of large quantities of fresh air is almost inseparably associated with that of heating the air, particularly in climates such as ours. Heat is communicated in three ways, namely, by conduction, by convection, and by radiation.

Conduction of Heat is illustrated in the communication of heat along a poker, one end of which is thrust into the fire. The particles of the poker in the fire pass on the heat, by contact, to the parts outside of the fire, and so the heat travels to the end of the poker. Some substances pass on heat in this way more readily than others; thus metals are all good conductors, some better than others. Wood is not a good conductor, neither is bone nor ivory. Thus in tea-pots made of metal the part of the handle grasped by the hand is usually separated from the main body of the tea-pot by a thin piece of bone or ivory. This prevents the conduction of heat to the handle, which can thus be safely grasped. Air is a bad conductor of heat, so also is water and other liquids, so also are stone, brick, glass, hair, and feathers (see Section V.).

Convection of Heat is the communication of heat by means of the movement of warm particles from one place to another. Thus while a mass of water is not readily heated by conduction, it is quickly heated by convection, that is, currents are quickly set up in the water by which the heat is distributed through the whole mass. When water is being heated in a kettle, as soon as the layer of water touching the bottom of the kettle is warmed by contact, it rises through the cold layers above, and cold water flows in to take its place. This becomes heated and in turn rises, so that the convection currents, set up in the water, speedily cause the whole quantity of water to be warmed. This is specially the way in which heat is communicated by air, which is, as we have said, a bad conductor. No sooner is one portion of air heated than a current is produced, the heated air rises, cold air flows in to take its place, and so the heat is distributed.

Radiation of Heat is not so easily understood. It is independent of air. It is because of radiation of heat from the sun that one is warmed when walking exposed to its direct beams. On a winter's day, when the frost is keen, if the sun is shining brightly upon us, we feel warmed by the rays. The heat we feel is not communicated to us by means of the air, for as soon as we fail to receive the direct rays, as by walking into the shade, we feel again only the keenly cold air. If it had been through the medium of the air that the sun's heat was communicated to us, we would have felt it equally warm in the shade as in the sunshine, for we are surrounded by the same air. Nay if, without moving from the spot where we feel the pleasant warmth poured upon us, the finest possible shield be interposed between us and the direct rays of the sun, if it be only a screen of tissue-paper, we feel at once the same sensation we experienced in passing into the shade. The heat is not communicated to us by the air, for even while we are enjoying the sun's warmth the thermometer may indicate the temperature of the air to be below the freezing point. The heat, then, from the sun is reaching us through the air, but its rays pass through the air without perceptibly warming it. It is only when the heat-rays fall upon a body capable of absorbing them that the body becomes warm. The air does not readily absorb heat; it allows the heat-rays to pass—that is to say, it transmits the heat—but it does not absorb it; but as soon as the heat-rays fall upon our bodies we absorb them and thus feel the warmth.

Open Fireplace or Heated Air.—Now we have stated at this length these methods of communicating heat, because they explain a great difference between sundry systems of warming. For example, if we compare the method of heating an apartment by the ordinary open fireplace with that by driving into it air previously heated, or heated in the apartment itself by hot water or steam pipes, the broad contrast will be readily shown. In the case of the open fireplace the heat is communicated to the apartment by radiation, not by heating the air. The radiant heat from the bright fire passes through the air without perceptibly warming it, and falls upon the walls, chairs, and other furniture, warming them. If a person be sitting within range of these rays he receives them and is also warmed. It is a quite familiar fact that if on a very cold night a person be sitting sideways to the fire, the side of the body towards the fire is unduly warm, while the other side of the body may be feeling half-frozen. It is plain this could not happen if the heat was communicated by the air of the room. It is due to the fact that the radiant heat from the fire is falling on one side and not on the other. Well, then, the walls, furniture, &c., of the room are warmed by the radiant heat, the air of the room not being directly heated at all. The air of the room does, however, become subsequently heated by convection currents. The air in contact with the warm walls, furniture, &c., becomes warmed, rises, and so currents are produced, colder air coming into contact with the walls, &c., and being in turn warmed, so that by and by the atmosphere of the room becomes warmer, *but it is always less warm than the inclosing walls, furniture, &c.* Moreover, the burning fire demands a large supply of fresh air, which it will draw for itself from every available crevice leading to the outside of the room, and thus the air is continually renewed and its warmth diminished. On the other hand, when air is warmed by some apparatus and admitted to the room, there is no radiant heat, and one breathes warm air. If the heating be accomplished by hot air or steam pipes in the room, or by such contrivances as the German stove, it is again by heating the air that warmth is communicated. Heat does radiate to some extent from the hot pipes and the stove, but the heat is chiefly distributed by the air becoming warmed by contact with the hot pipes, and convection currents being thus produced. Moreover, the absence of the open fireplace does away with the guarantee of a certain amount of ventilation constantly going on, and in the absence of a very efficient system of ventilation by special inlet and outlet openings, the evils of bad air are added to the disadvantage of rarefied air, the disadvantage of a deficient quantity of oxygen with every breath inspired. These are the causes of the languor, want of freshness, feeling of oppression, and headache so common in halls or rooms heated by means of hot pipes, and not provided with a very efficient system of ventilation.

At the same time in cold climates there is almost a necessity for some arrangement for warming to some extent the large volume of air required for efficient ventilation. That is to say, while the open fire is the most desirable and simple means of warming rooms of ordinary size and small halls, it is frequently scarcely sufficient in cold raw climates, or at cold seasons of the year, and various methods have been suggested for supplementing it.

The Construction of Grates.—The ordinary grate, however, is not constructed to produce the full effect the open fire is capable of. As already indicated, it warms a room by radiation, but the ordinary grate is not usually constructed to permit radiation to take place to the fullest possible extent. There are various reasons for this, some of which may be stated. First, the coal is not completely burned. The air does not gain access to the fire in such a way as to produce perfect combustion, not necessarily because of an insufficient supply of air, but because of a bad distribution through the burning mass. Much material, in the shape of soot, smoke, and gases, escapes up the chimney, which would have given off a great deal of heat had complete union with the oxygen of the air been effected. Then, according to General Morin, five-eighths of the heat are not utilized in heating the room, but are lost up the chimney. The material of which the fireplace is made is often not the best for radiating heat into the room, and its shape is not adapted for such a purpose, for example the old large square fireplaces. It was Count Rumford who, in 1796, pointed out the waste of the heating capacity of the fuel which the style of grate then in use occasioned. He brought the grate to the front of the hearth recess, reduced the width of the back of the grate to one-third of that of the recess, and built the back and sides of the grate of non-conducting material, such as brick or fire-clay. An important alteration was that by which the sides of the grate were made to slope outwards from the back, so that when they became hot they radiated their heat into the room. The wide throat of the old chimney was narrowed, so as to diminish the total volume of air drawn into the chimney by which the fireplace was continually being cooled down, and which also secured more complete combustion of the coals. These are the general principles which ought still to guide the construction of fireplaces. Glazed tiles may be used for the back and sides, as they emit the heat more rapidly than unglazed. A fire-brick slab sloping slightly upwards from the back assists the radiation of heat and the combustion of the fuel. Many grates of modern construction are provided with special arrangements to prevent all the cold air entering directly. Part is led from below up flutings on the back, and in other ways, to be delivered partly warmed into the heart of the fire, to ensure complete combustion. Such improved grates also economize fuel.

Teale's "Economizer."—Mr. Pridgin Teale has suggested a very simple arrangement which he maintains effects more complete combustion, causes more heat to be given out to the room, and saves fuel. It has the advantage of being very cheap, and capable of being applied to any form of grate. He removes the ash-pan from under the grate, and incloses that space by an iron plate of a shape to fit the grate, resting on the hearth and rising as high as the bottom bar of the grate. The space below the grate thus becomes a closed chamber; air is not permitted to enter the fire from below at all, and the draught is thus diminished and slower combustion secured. The coal, however, is more completely burned, for since no cold air enters from below, the bottom layer of coal is kept very hot, so that the cinders become consumed, and the fine ash produced drops through the bottom into the inclosed air space. Then the inclosed air space is a hot-air chamber, giving out considerable heat and maintaining a uniform rate of combustion. The iron shield Mr. Teale calls, on this account, the "Economizer."

All the contrivances noted, however, are simply devices for utilizing to the utmost the radiating power of the open fireplace.

It should be observed further that the heat given out from the open fireplace would be of much greater value for heating an apartment if the fireplace were situated not in an outside wall, owing to which much heat is lost, but in an inside wall. The heat, which, in the former case, is lost by being passed through the wall and given off to the external atmosphere, would, in the latter case, be wholly utilized in warming the atmosphere of the house. This, of course, implies economy in fuel.

The Galton Grate.—We must now refer to a method by which the open fireplace is made use of also to warm the fresh air entering the room for ventilation. The air so warmed should not be heated above 54° to 60° Fahr. By such a contrivance the advantages of the open fireplace are retained and the disadvantages of admitting large volumes of very cold air to the room got rid of. The grate called the "Galton Grate," devised by Captain Galton of the Royal Engineers nearly thirty years ago, is the example of such an arrangement. Behind the grate is a chamber into which pure air from the outside is admitted. The back of the grate is provided with a set of gills, in passing over which the pure air is warmed. This air then passes upwards by a flue alongside of the chimney and enters the room above the fireplace. This chamber and flue are altogether shut off from the grate and chimney and obtain their air from the outside only. There are now many forms of such open fireplaces.

The warmed air entering the room above the chimney-piece is caught by a current passing upwards to the roof in front of the fireplace, and is thus broken up near the ceiling into various currents, so that it is rapidly distributed through the apartment.

Stoves, and specially **Slow-combustion Stoves,** are now being largely employed, in particular for the heating of halls, &c. They may be made of iron or glazed earthenware. The latter is a worse conductor of heat than the former, but it in consequence parts with its heat more slowly and regularly, so that a uniform temperature is more surely maintained by an earthenware or brick stove. The value of such stoves from an economical point of view is due to their internal arrangements. The smoke and gases given off from the burning coal are conducted upwards and downwards within the body of the stove before they are allowed to escape by the chimney, and thus they are caused to part with the main portion of their heat to the material of the stove, which in turn gives it off to the air of the apartment. Then, once the fire has been lighted, the doors are closed, and the air supplied very slowly, so that one charge of fuel will last from morning to night; the heat will be slowly given off, and utilized to the greatest possible extent. Such contrivances, therefore, create no draught of any value for ventilation, while their value for heating purposes being dependent upon the warming of the air, and not on radiant heat, doors and windows are usually kept closed to get the full effect from them. They are, therefore, likely directly to create the temptation to inefficient ventilation. Such stoves are in constant use in Germany for warming purposes, no open fireplaces being used; hence the designation **German Stoves.** Any one who has only experience of their use for warming the atmosphere of a whole house, the stove being in the hall, will not realize their disadvantages to the same extent as one does who has experience of their employment abroad in the living- and sleeping-rooms. When the fire is charged in the afternoon, the doors and windows of the bed-room are carefully closed, and when one enters the room for the night, the atmosphere feels stifling and is almost unendurable. One instinctively rushes to open the window for a draught of fresh air. There is, however, a modification of such stoves by which a pipe carrying fresh air from the outside may be passed through a part of the stove, and allowed to escape at the top into the room, so that a supply of fresh warmed air is obtained. But this implies a larger consumption of fuel, a more rapid combustion in the stove, else heat would not be produced sufficient to warm to any degree the fresh air passed in.

Gas Stoves.—Wherever gas stoves are used it is necessary to ensure that the products of combustion are passed off to the outside and not permitted to escape into the apartment. The gas ranges, now so commonly used for cooking purposes, err in this respect. The lower part of the range, occupied by the oven, is provided with a flue, by which the products of combustion are conveyed to the outside, but the various gas jets, arranged in ring form &c. just under the grating of the top of the range, give off all the burnt gases into the apartment, and the smell is perceptible immediately after the gas has been lighted. If a gas stove is fitted into the ordinary grate recess, so that all the combustion products escape up the chimney in the ordinary way, the objection is removed; but usually the gas range stands out into the floor at the side of the ordinary grate, in addition to which, or instead of which, it is being employed. This is decidedly objectionable. It is now also common to see an ordinary range adapted for gas, at least to some extent. The oven may be heated by gas, and on the hot plate above the oven, it is also becoming quite usual to fit ring-jets on which a kettle, pot &c. could be boiled. In this way no evil is incurred, for the burnt gases escape up the chimney as the smoke from the ordinary fire. Some of the gas stoves adapted exclusively for warming purposes also exhibit the fault of discharging their burnt gases into the apartment, and these are not to be recommended. Only those should be selected which are provided with a flue; and there are now many forms which can quite easily be fitted into the fireplace of the ordinary grate, discharging their waste up the chimney. Gas stoves of whatever form are not economical, for continuous burning, at the present price of gas. Asbestos stoves heated to redness by gas are so arranged as to give out a large amount of radiant heat, but they are only economical owing to the fact that they can be put out at any moment and relighted with equal rapidity. They are expensive if used for any time on end. If they are used only now and again, for a short period, then they may be more economical than coal, and they save an enormous amount of labour and dirt.

Gas, however, is now being employed for warming the fresh air admitted to a room for ventilation, and may be combined with modifications of inlet tubes such as have been described, and with an open fireplace. Fig. 280 is an illustration of an air inlet tube A, in the interior of which is a small chamber C provided with a gas jet D. This chamber is continued into a pipe B coiling through the compartment, through which pass the heated products of combustion. This pipe may end in a chamber G open to the outside by H, but shut off from the space of the inlet tube, and containing some material for absorbing the waste gases that escape; or the pipe may be carried up the inlet tube J, again to pass out above. The gas jet is supplied with air for its combustion through the openings E and F. Air enters the space of the inlet tube, and is warmed as it passes through it by contact with the coiled pipe. It may be filtered before passing into the room by the conical canvas bag shown. The entering air is admitted through an opening guarded by a shutter, K, which is raised or lowered to any desired extent by the cord passing over the pulley L, and counterpoised by the weight, M.

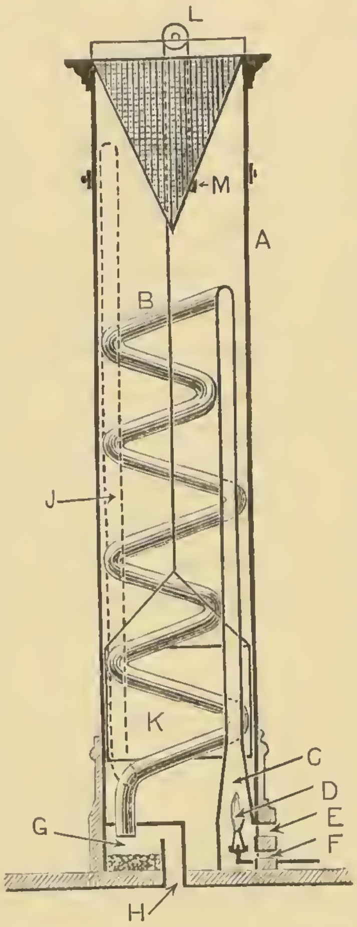

Fig. 280.—Air Inlet Tube fitted with Fresh Air Warming Arrangement (Boyle).

In concluding these paragraphs on the very difficult subject of ventilation and warming, the author does not wish to ignore the fact that the review of some of the chief methods now adopted for introducing an abundant supply of fresh air into apartments without unduly lowering the temperature, while it may be very valuable to the man who wishes to build his own house or already owns one, may not afford much aid to those who are simply tenants and have neither the means nor the opportunity of adopting any of the more elaborate systems. They may wish at the same time, and may be able to adopt, some simple and inexpensive method, as far as possible to achieve the ends desired. To such it may be said, that if they will give themselves a little trouble in the securing of grates which are constructed to give out the greatest amount of heat, and which are now almost as readily obtained as those of bad construction, and if, in addition, they can fit up such an inlet regulating ventilator as Sheringham's or others of like construction, or Teale's, they will do much to accomplish what is required.

SECTION IV.—HOUSE DRAINAGE.

Waste from Dwellings:
  Its Character and its Destruction by Natural Agencies.
The Disposal of Waste from Dwellings:
  Drains and Sewers;
  Cesspools;
  Sewage Gas—Its Effects and Its Dangers;
  Traps—The Syphon—Access Syphon—Hart Trap—Disconnecting Traps;
  Bad Forms of Traps—The Dipstone Trap—The Bell Trap;
  Ventilation of Traps and Drains;
  Drain Pipes, Sewers, &c.—Proper Material for Drains—Mode of Joining Pipes—Position of Pipes.
Common Defects in House Drainage:
  Defects in the Soil-pipe;
  Defects in Waste Pipes;
  Defects to be looked for in Drains—How a House Ought, and Ought not, to be Drained.
The Testing of Drains.
The Flushing of Drains.
The Water-closet:
  The Pan-closet, Hopper Closet;
  Wash-out and Valve Closets;
  The Connection of Water-closet and Cistern.
Sinks.
Drainage and Water Supply.
  Cisterns—The Material of their Construction—Their Position and Protection from Frost.
Dry Methods of Removing Excreta:
  Moule's, Morrell's, and Goux' Arrangements.
Sanitary Maxims.

HOUSE DRAINAGE.

The Nature of Waste from Dwellings.—In this section we have to consider various methods for the removal of waste from dwellings. What is the nature of that waste? It is partly liquid and partly solid. The liquid portion consists of waste water from baths, sinks, wash-hand basins &c., and we may also add rain-water caught on the roof and led off by pipes. In all this there is both animal and vegetable matter, capable under certain conditions of temperature of undergoing rapid decomposition and giving off putrefactive gases. There remains to be added the urine voided from the bodies of the inmates of the house, which very speedily decomposes. The solid portions of the waste consist of refuse of food, both animal and vegetable, dust, ashes &c., and the solid waste passed off from the bowels of the inmates. In primitive conditions, and in places where the population is sparse, there is no great difficulty in suitably disposing of such waste. The organic material, both animal and vegetable, which such waste contains, in ordinary course undergoes decomposition or putrefaction. This, as has been pointed out at length in Section XIII., Part I., is the process by which complex bodies are broken down into simple bodies or elementary substances, in which form they are again useful for the nourishment of plants, in which form, also, they are harmless. Thus the urine contains urea, the waste of nitrogenous foods consumed in the body. If it be exposed for a time to the air we know it becomes offensively ammoniacal in smell, because the urea has become transformed into carbonate of ammonia, and if it be thrown upon the soil the nitrogen it contains is available for the life and growth of the plant. So it is with the other organic substances. This process of breaking down, of reduction to simple, inoffensive, useful, substances, is accomplished chiefly by the agency of the oxygen of the air; it is essentially a process of combustion, of oxidation, of burning, and it cannot be accomplished unless there is free exposure to air, or free exposure, under suitable conditions, to substances which will yield the needed oxygen in suitable quantity. If the waste be freely exposed to the open air, this process of oxidation will in good time be accomplished, and then the waste becomes valuable for scattering over fields, and so on, to enrich the soil. Suppose the waste in its fresh state be scattered over the soil, it is freely exposed to the air, the liquid portion which sinks into the soil, meets the air in the soil, the ground air, and gets the necessary oxygen. This distribution over the soil can, however, be accomplished only during certain periods of the year, and it may be, therefore, necessary to accumulate it in heaps till the period when it can be used. This also may be done without harm, if the accumulation be made at a proper distance from the dwelling. If the waste be cast into a stream, it is rapidly carried off. In the water it also undergoes combustion, not because of the water itself, but by the agency of the oxygen, dissolved in the water to the extent of something like 2½ cubic inches to the gallon. In time no sewage, as such, will be found in the stream; it has all undergone oxidation. Where the population is sparse, then, the resources of nature are quite sufficient to deal with the waste from human habitations. As men congregate, however, the circumstances are changed. The bulk of waste becomes too great for the natural resources of the place to cope with. It becomes necessary to make arrangements for its removal to great distances. If it be cast into a stream, the current may be sufficient to carry it rapidly away, but then the stream is seriously polluted, and if no great distance separates the place where the waste enters from another, lower down the stream, where other dwellings exist, there is no time for natural purification to occur. The magnitude of the difficulty becomes enormous when the waste of a town has to be dealt with. A few figures will show this clearly. If we consider simply the waste cast off from the human body, 40 ounces per day of urine and 2½ ounces per day of solid excrement per head is a low average for both sexes and all ages. This makes, for a population of 1000 persons, 260 gallons of urine and 156 pounds of solids per day, or 91,250 gallons of urine and 25 tons of solid excrement per year. If there be added to this waste water of all kinds and solid refuse, the amount to be disposed of becomes enormous. In order to simplify our consideration of the question, we shall begin by considering the disposal of the human waste, or excreta (from Latin *excerno*, to separate out), along with waste water. It is necessary to provide channels for waste or slop water from houses, at any rate, and we shall consider that human excreta both liquid and solid, are cast into the same channels to be carried off in the same way. We can consider later other methods proposed for dealing with solid human excrement, as well as the means of disposing of the other solid refuse of the dwelling.

This system of casting into the same channel waste water from the dwelling as well as human excreta is common, because the water carriage thus provided is an easy method of removing the solid excrement. It is efficient also and not expensive. The channels may ultimately be made to discharge their contents into a river or into the sea, or into tanks where the collected material may undergo some purification by chemical means, to be afterwards disposed of in some convenient way, or it may be collected into reservoirs and thence distributed over soil for manurial purposes.

Disposal of Waste.—Our present concern is its speedy removal from the dwelling. This is apparently simple enough. To the sink, wash-hand basin, water-closet &c., a pipe is connected. These pipes join one another and form a common pipe leading out of the house, or they are branches of a common pipe, passing through and ultimately leaving the house. Into this same main pipe pass pipes collecting the rain-water from the roof. The rain-water pipe may pass down one side of the house, then below the basement to join the main pipe at the other side. Thus rain-water from the roof, waste water from bath-rooms, dressing-rooms, kitchens, and sculleries, and excreta from water-closets all enter one common pipe either within the house, or the pipes, which they enter, ultimately join one common pipe outside the house. Moreover the pipe from one house or one tenement joins that from another house or tenement, the common pipe being now enlarged for the purpose, and as this passes onwards it receives additions and branches from other houses &c., becoming larger as it proceeds and carrying ever-increasing quantities of waste. The pipes inside the house are called **drains**, and the same term is applied to the main pipes leading from the house or tenement, but the larger pipes or channels into which the drains from several houses pass are called **sewers or common sewers.** The sewers pass on until they open let us say into the river, into which they discharge their contents.

Now let us consider what this apparently simple system means. The material in the drains and sewers is covered up, excluded from the air, until it is discharged into the river. It may have to pass through miles of piping before its exit. Air is present in the drains and sewers to some extent and also in the water, and thus some amount of oxidation can occur, but the oxygen obtainable is a mere fraction of what is necessary, and thus the natural process of reduction of the organic substances to simple and harmless elementary bodies cannot occur Meanwhile, however, putrefaction is not prevented, decomposition proceeds to some extent, and putrid gases and all the noxious effluvia capable of being given off from such mixed ingredients fill the pipes. If the connection of the house drains with the sewers is the simple one indicated, it is plain that there is no barrier to the passage of the sewer gas into the house. The waste as it enters the house drains is not yet in a state of putrefaction and it is carried rapidly away by the water, so that thus far no harm can arise. But the atmosphere of the house is in direct communication with the atmosphere of the drains and sewers, and that of the house being warmer, there is an actual suction exerted upon the sewer gas, drawing it into the house. Moreover that is not all. Such a simple means of connection implies that the atmosphere of one house is in direct communication with another through the drain-pipes, which are a sort of secret subterranean passage, and a man who is scrupulous about having fresh air in his own house may yet enjoy the foul air of his neighbours through this unsuspected means of communication.

Cesspools.—When it was not possible to lead the sewage off by a stream it used to be the practice, and indeed in a restricted sense is so still, to build a cesspool, into which the drains from the house were carried. These cesspools were built of brick or other porous material, and allowed the liquid portion of the material to ooze into the ground, the solids being retained. When the cesspool was full, the retained solids were available as manure for field or garden purposes. Even where the drains of the house were connected with a general sewerage system for removing the sewage, cesspools were interposed before the drains joined the sewers for the interception of the solid portions, the liquid parts being provided with an overflow into the sewers. It was not even customary to empty the cesspool when full, unless there were obvious advantages by doing so in the securing of manure, but, to save trouble, when one cesspool was full a new one was dug, and the sewage conducted into it, the old one being simply covered over. Not only was this usual in country districts and at a distance from the house, but it was also common in towns, for example, in London, and the cesspool was actually dug in the ground covered by the house itself, all the sewage from the house being conducted into it. When one was full, a new one was dug. Thus the late Mr. Eassie writes: "Many of these cesspools are to be found in the older houses of London in the basement, and oftentimes under the kitchen floor. . . . The custom was that when one cesspool was full another should be made, and thus a great many of these receptacles are discovered in one house. . . . It is not uncommon to find cases where the house was built first, and, for want of a suitable fall, the cesspool dug out inside the house. This was the case especially in large mansions with ample cellarage room, and I have discovered and removed as many as eighteen cesspools in one mansion. . . . On one occasion I laid bare five of them, just outside the walls of a residence, and they averaged forty feet in depth! . . . There are in London yet thousands of houses which drain into cesspools, and have only the overflows taken into the sewer. As a matter of course all these cesspools should be abolished, and when a block of old houses is pulled down in a city like London, the whole site should be ploughed up in a search for these old receptacles, as otherwise some of them may come to be left inside the walls of the new house."

Under no circumstances ought cesspools be allowed to exist in towns or where there are numerous houses in immediate proximity to one another. In the country they may be unavoidable; but if so they ought to be so constructed and situated as to do away with the risks attendant upon them in ordinary circumstances. Suppose a country house built upon a slope, and the sewage carried to a cesspool at some distance down the slope, and this at a considerable distance not only from the house but below the house level, and suppose that still below this there spread out fields under cultivation, then it will be admitted that, provided the house pipes are properly disconnected from the cesspool, as described on p. 709, no harm can possibly arise from the cesspool being built of porous material and permitting the sewage to ooze through it into the field below, where it will enrich the soil and fertilize the crops. If, however, at any subsequent period these fields should come to be feued for villas or other dwellings, the sewage filtering down on them from behind could no longer be tolerated. Where, however, there is no proper fall the cesspool must be water-tight, else the escaping fluid permeating the soil would reach the foundations of the house, allowing unhealthy emanations to reach the dwelling, unless the cesspool were at a great distance. It might also gain access to the water supply and pollute it, almost certainly if the water were obtained from a neighbouring well. The cesspool should then be water-tight, it should be properly ventilated, and the inlet pipe should deliver the sewage through a disconnecting arrangement, to ensure the impossibility of sewage gas passing up the drains to the house. It is deemed also best to lead the sewage through some straining tank, which will permit only the liquid sewage to pass to the cesspool. In such a case the intercepted solids should be collected daily and mixed with earth and perhaps some material to remove smells, and then made use of for manurial purposes. The liquids collected in the tanks would require either to be at regular intervals pumped out and carried away, or some arrangement might be adopted whereby the liquid could be led away into pipes and used for irrigating purposes, the pipes starting from the cesspool being for some distance of glazed earthenware, passing into ordinary agricultural pipes.

Dangers of Sewage Gas.—To return, however, to what we have described as the apparently simple and easy method of removing sewage from a dwelling by pipes in direct communication with the interior of the dwelling. What are the evils of such a system? Let us suppose also that these pipes are directly connected with a cesspool either inside or outside the house. In such circumstances, as already said, sewage gas inevitably gains access to the dwelling. What is the nature of this sewage gas? It contains the ingredients of common air, oxygen, nitrogen and carbonic acid gas, the oxygen in less proportion and the carbonic acid gas in greater proportion than ordinary atmospheric air. It also contains gases from the decomposing sewage, marsh-gas or carburetted hydrogen, sulphuretted hydrogen in small quantity, that horribly fetid gas which gives the smell to rotten eggs, and ammoniacal vapours. The quantity of these noxious gases varies with the construction of the drains and sewers and with the amount of ventilation provided for them. Where the ventilation is good these gases may exist in extremely minute quantity, scarcely appreciable. But there is besides fetid organic matter in the sewer gas, whose character has not been precisely determined, but which imparts to the sewer gas its specially hurtful property to health. Even when such fetid organic matters are in such minute quantity as not to be detected by the senses they are yet capable of doing much harm to persons breathing for any time the atmosphere contaminated by them. Let us now ask what effects does such sewer gas produce upon the body. Can emanations from drains occasion typhoid fever, diphtheria, cholera, blood-poisoning, as is so often alleged? This question would be answered in different ways by different people. I shall endeavour to answer it in a way consistent with recent discoveries regarding the causes of these special diseases. If we are to accept as true the modern investigations regarding germs and their part in the production of disease, and everyone accepts them as true, then scarlet fever, measles, diphtheria, typhoid fever, cholera &c. must be held to be the result of the activity within the body of the particular germs of the particular disease, introduced from without, just as a crop of barley, corn, &c. can only be produced from a soil in which their seeds have been sown. Further, just as "men do not gather grapes of thorns, nor figs of thistles," so it has never yet been found that the germs or seeds of one disease can by any peculiarity of circumstance produce another disease. Measles cannot "pass into" scarlet fever nor scarlet fever into diphtheria. If a patient recovering from scarlet fever is attacked by diphtheria, we can only conclude that he has received into his body not only the seeds of scarlet fever, but also the seeds of diphtheria, however impossible it may be to discover how they have reached him. Moreover if a person is attacked by measles &c. we are compelled to conclude that the germs or seeds of measles have gained entrance to his body, just as if potatoes or corn spring up in a field we say the seed must have got into the soil, whether anyone has been known to sow it or not. To say that a child caught cold, and it "turned into" diphtheria is, according to modern science, as absurd as it would be to say snow fell on a field and from it there sprang up turnips. This being understood let us, in the first place, suppose that a group of houses drain into a common sewer, and that into that sewer there has been discharged only the ordinary simple excreta of the dwellings, no disease being in the houses and, therefore, no excreta containing disease germs of any kind gaining entrance to the drains. Suppose these drains are so constructed that sewer gas from them passes into every one of the houses, what evils may it do? Let us suppose that the inmates of the houses are all, to start with, in the enjoyment of excellent health, living regular lives, with good food, good water supply, uncontaminated, and with plenty of outdoor life and exercise. Then they may live for years in the houses and finally leave it for some other abode entirely unaware of the unhealthy condition in which it actually is. The natural healthy body, that is to say, has a well-marked resisting power to unhealthy conditions. But if any of the inmates are debarred from going out for prolonged periods, then the constant living in the contaminated atmosphere is likely enough to tell, almost certainly will tell, sooner or later, though perhaps only in vague ways. It is commonly the women, whose duties keep them at home, and not the men, whose business continually takes them out of the house, who show the first indications of any insanitary condition. But in particular children are readily affected, and specially young children. They have much less resisting power; and young children, not yet of school age, are so apt, because of weather conditions, to be shut up for many days at a time in the house that they are often the first to appear to be not in a satisfactory state of health. So that it is in wet weather signs of disease are likely to appear, and in cold weather when doors and windows are kept shut and there is less communication with the pure air of the outside. When, however, the insanitary condition of the house asserts itself it will not be by the appearance of a specific disease, such as diphtheria, typhoid fever &c., for we have assumed that there is no way by which the germs of such diseases could enter the drains. Let it be observed that we do not say such diseases may not appear in any of the households, we only say such diseases cannot arise *from the sewer gas* which is gaining entrance to the house. If such diseases do appear it is because they have been communicated in some other way, by infection from some person who has suffered from the disease or has been in its immediate neighbourhood. Further let it be noticed that persons living in a badly-drained house are all the more apt to fall victims to any of these specific diseases they may meet outside, because the frequent breathing of the sewage-tainted air has diminished their resistance to disease. *In short the emanations from simple sewage cannot produce a specific disease, but they can act injuriously upon the general health of the inmates of the houses producing disorder and disturbance of a variety of kinds, to be noted immediately, and diminishing the natural disease-resisting power of the healthy body, so that the person is a fit subject for taking any disease he may be exposed to; and they act thus most particularly upon any inmates of the house who have little outdoor exercise such as women and young children.* In another way also the sewage-tainted air may prove greatly injurious. If one of the inmates has been seized with illness, has caught, for example, a severe cold, or has been seized with inflammation of the lungs, then his general vigour is reduced, the foul air has its opportunity, and seriously delays and impairs his recovery. Or again the wife is confined of a child in the house, and her recovery is neither so speedy nor so satisfactory as everyone had expected. Her resistance to unhealthy conditions is diminished and so the foul air has its full effect upon her. In all these vague, ill-defined, ill-understood, and unsuspected, ways are sewage emanations daily, aye hourly, affecting the health, the vigour, the life, of large masses of the people, specially in large towns, and there are few who think of it, fewer who know of it, and many who laugh at the notion of it. Yet the author could give instance after instance, from his own experience, in which the operation of the sewage gas has been made out as conclusively as a mathematical demonstration.

But simple sewage emanations may do more than this. They not only diminish disease-resisting power by lowering the vigour of the general system, they not only take advantage of a general system lowered by other causes, but they produce actual diseases, *though of a non-specific character*, and specially, as already said, in those most exposed for long periods to their influence. In adults the symptoms are often only those of a general *malaise*, of a general state of ill-health, such as want of appetite, bad digestion, headache, pallor &c. Frequent sore-throat, sickness and vomiting are common. Marked disorder of the stomach and bowels, purging and diarrhœa, are also consequences. In children very marked symptoms are frequent, such as severe sickness, and vomiting and high fever are quite common, as well as less-defined symptoms of general ill-health, decline of vigour, and so on.

In the next place let us suppose that the sewage is not of the simple kind we have at first assumed. We shall take it for granted that in a house connected with a system of drains, in direct communication with all the other houses discharging into the system, there are one or more cases of some specific disease, such as scarlet fever, diphtheria or typhoid fever, or that there are cases of several of these diseases in different houses of the system. Then the excreta of these patients are cast into the drains. Into the sewage there gain entrance the germs or seeds of these diseases, some of which may multiply there. If the drains are not properly flushed, or if there is a block anywhere, the sewage may become charged with the germs, and it is at least possible that by the bursting of bubbles of gas, produced by decomposition, germs may become disseminated in the sewer air, and may be drawn into the houses connected with the drains. If the drains are badly laid or the sewers are badly constructed, leakage will take place into the soil, and if the water supply be drawn from wells in the neighbourhood, the water will almost certainly become contaminated and an epidemic is nearly a certainty. Diarrhœa, dysentery, typhoid fever and cholera have thus been propagated. But that these diseases can be propagated by the sewer gas alone, in such circumstances, seems from numerous experiences almost certain. At the very least the risk is enormous. Besides the diseases named diphtheria and a form of inflammation of the lungs (epidemic pneumonia) have been traced to such polluted air. In 1888 an epidemic broke out in an industrial institution in Glasgow in which over 60 boys were attacked, four dying after a few hours' illness. A form of inflammation of the lungs was characteristic of this epidemic. Careful investigation laid the blame on the sanitary arrangements. The institution was in the immediate neighbourhood of an old burial-ground, effluvia from the soil and from the drains gained access to the building, and school-rooms and dormitories were not supplied with pure air sufficient for the number of inmates. The conclusion seemed irresistible that these conditions were the cause of the outbreak. Many more illustrations could be given of a similar kind. Instances are numerous where the opening of blocked drains, old cesspools, &c., has been attended by epidemic fevers, with fatal results.

Sewage gas, pure and simple, is then injurious to health and productive of disease, how enormously is the danger increased from emanations from sewers, into which discharges from multitudes of houses, including the excreta from probably a great variety of diseases, are poured? It is absolutely necessary, then, that some means be provided which, while permitting the free and rapid escape of waste from dwellings into drains and sewers, shall effectually guard against the possibility of foul air from the drains and sewers gaining access to the houses. For this purpose two means are adopted, one seeks by the use of appliances called traps to intercept the backward passage of sewage gas, and the other seeks by ventilating the drain-pipes to have the air within them constantly as pure and fresh as possible. We shall now describe in detail the different appliances and their method of application.

Traps. The simplest form of trap is the **syphon**, shown in Fig. 281. It is a simple dip in the pipe, the effect of which is to retain a quantity of water which acts as a seal preventing the backward passage of air from the drain into the house. There are possible objections to this kind of trap. If it is shallow it may readily be rendered useless. For it is to be noticed that the effective barrier to the passage of gas is the layer of water above the line A B. If, by evaporation or otherwise, the water fall to the level of the lowest part of the bend C, that is, the level indicated by the line at B, the slightest further diminution of water will open a way for the gas from the outlet side through the bend to the house. This might happen if the bend were shallow and the trap small. Further if the pipe be a small one the water in the trap may be syphoned off. If the drain below the trap be running full the suction action exerted by the mass of running water may draw the water from the trap and leave it wholly or partially empty, so that there would be no longer any obstacle to the backward passage of gas. These evils are overcome by ventilating the trap as explained further on. But suppose some obstruction to the outflow further down the drain causing some retention of sewage and the development of a large quantity of gas, the pressure of gas might so increase on the outlet side as to impregnate the water, and perhaps cause the gas to bubble through the water and so escape into the house. This is also met by ventilating the trap, as shown in Fig. 283.

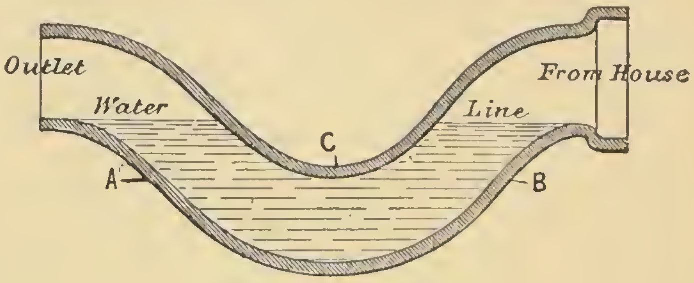

Fig. 281.—Syphon Trap.

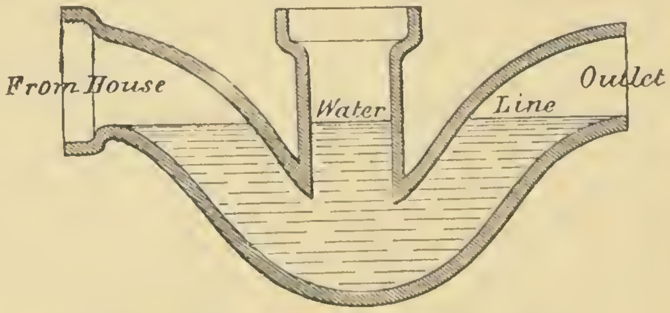

Fig. 282.—Common Lying Trap or Access Syphon.

The **access syphon** is shown in one form in Fig. 282. The additional pipe is let into the centre of the bend. If it comes up to the level of the surface the top may be covered with a grating and then it acts as a ventilator. It is usually simply covered with a slab of stone and is then used for an inspection or cleaning "eye," permitting in such a case no ventilation. It is, however, not a very good kind to employ. Its position is such that floating excreta are apt to be retained in the added tube, not being swept out by flushing water, and undergoing there decomposition.

Ventilating Trap.—A form of ventilating trap is shown in Fig. 283, where A is the inlet pipe from the house, B is the outlet to the drain, the two being cut off from one another by the trapping water. The ventilating shaft opens at D, and is fitted with a grating. This is the general form of trap for use outside a house. It practically cuts off the house-pipes altogether from the outside drains, the air-chamber disconnecting the two systems. This trap is, therefore, also called a **disconnecting trap**. It is placed outside the house on the soil-pipe drain at a little distance from the house. If it cannot be taken any distance from the house wall, care should at least be exercised that the grating is not in the immediate neighbourhood of a door or window, else a smell will certainly be felt from it, and be occasionally wafted into the house. Fig. 284 shows a similar trap (Buchan's) with an additional opening D for access for cleaning purposes. The cover of D should be fixed down with mortar, and a small brick chamber built up to the ground level, covered with a slab, so that access can be had. Note that by mistake this opening D is sometimes made the ventilating opening, and is covered by a grating. It ought not to be so. C is the opening to be covered by a grating. With such an arrangement, supposing the waste water from baths, sinks &c. as well as rain-water from the roof, to be carried off by a pipe, separate from the soil-pipe, such a pipe could discharge in the open air, over the grating of the ventilating trap. Thus neither the soil nor waste-pipes could be the means of carrying sewage gas backwards into the house. It is not desirable, however, that soil, waste and rain water should pass through the same ventilating trap in the immediate proximity of the house. The soil-pipe should be separate altogether from the waste and rain-water pipes, and these latter should be cut off from the soil-pipe drain by a separate ventilating trap, as shown in detail on *fig. 1*, Plate IX^b. Where, however, from the construction of the house and the arrangement of its drainage, such is not possible, as in some tenement houses, the above arrangement should *at least* be carried out.

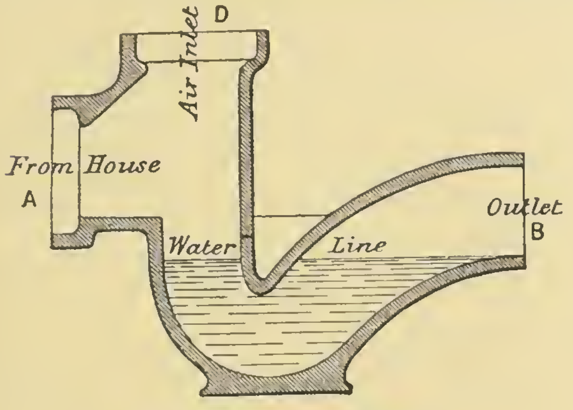

Fig. 283.—Ventilating Trap.

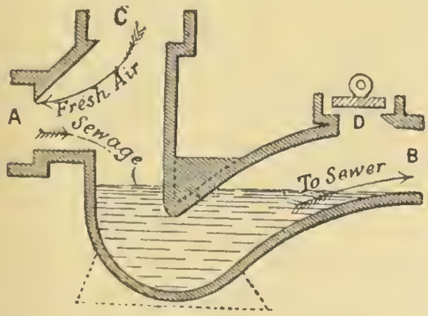

Fig. 284.—Buchan's Ventilating Trap, with Access Pipe.

The **Hart Trap** (Fig. 285) is a recent form of trap, advocated by sanitary engineers for disconnecting bath, rain-water, and such waste pipes from drains. It also is a ventilating trap. It is placed at the foot of the waste pipe, which discharges openly immediately below the level of the ventilating grating. The shape of the trapping portion is such as to secure a complete flushing of the trap, and a thorough washing out of all solid material into the drain.

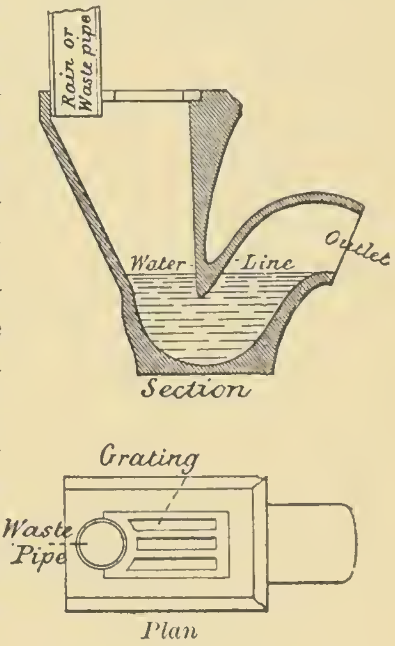

Fig. 285.—The Hart Trap.

The **Gully Trap** is a form of disconnecting trap, placed outside the house in a yard &c., into which rain or waste pipes open, either above or immediately below the ventilating grating. Its form and arrangement are represented in Fig. 286. It is used where one desires to prevent the entrance into the drain of material liable to silt up and block the drain, such material as may be washed down from roof

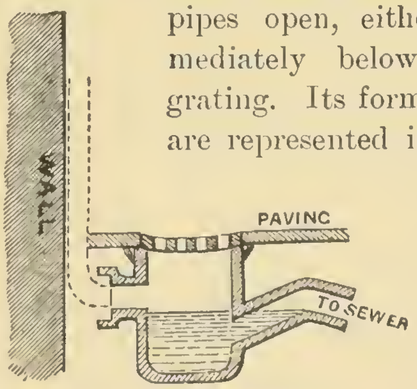

Fig. 286.—Gully Trap.

gutters, or washed in from yard sweepings &c., and which can be removed from time to time as it collects. In the case of the trap for a soil-pipe the shape is not the same, being such that the flushing water will wash everything down into the drain and prevent the interception of any solid material.

A Syphon-trap for pipes, placed to receive surface water, is shown in Fig. 287. The top A is provided with a stoneware grating through which surface water passes.

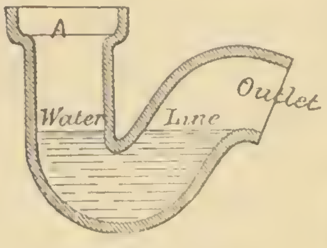

Fig. 287.—Syphon trap Surface Water.

Bad Forms of Traps.—The general form of trap of greatest use having been indicated, it may be well to give a warning against the use of some, whose employment is more likely to be attended by evil than good. Fig. 288 represents a form of trap which is a modification of the old form of cesspool. It is simply a cesspool, from the roof of which a slab of stone dips down far enough to be below the level of the outlet-pipe, so that it enters the water of the cesspool. The effect of this is completely to divide the cesspool above the water into two chambers, not communicating with one another except through the water. Sewage gas passing up by the outlet-pipe would thus be unable to pass to the inlet-pipe. This is the **Dipstone-trap**. It is an exceedingly bad form, because excreta and decomposing material are certain to be retained in the bottom, because of the very shape of the cesspool, and foul gases will pass off directly on the side of the inlet-pipe.

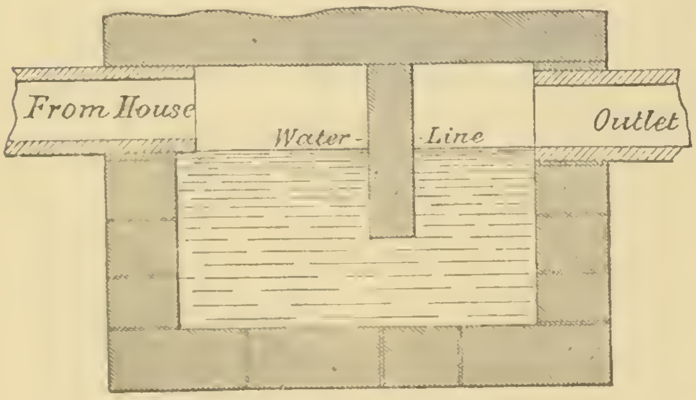

Fig. 288.—Dipstone-trap.

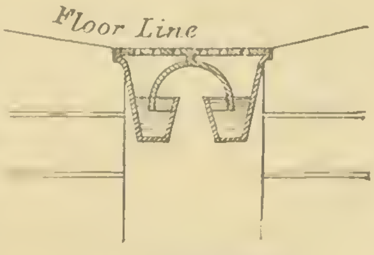

Fig. 289.—Bell-trap.

The **Bell-trap** (Fig. 289) shows a form of trap condemned by almost everyone, and yet very extensively used for carrying off the surface water from outhouses, dairies, washing-houses &c. It is quite commonly found in the basement of houses, where there are stone floors, and a pipe is laid to carry off water running upon them. It is called the **bell-trap**, because of the shape of the cover. It is a square box-shaped trap into which the drain opens, as shown. The box is covered by a grating, to the under surface of which is attached a cup or bell-shaped piece. Water is retained in the box till it rises to the level of the opening of the drain, when it passes down. The cup projects downwards lower than this level and thus dips into the water. While water can pass freely through the grating, over the bell and enter the drain, sewage gas is prevented by the layer of water between the opening of the drain-pipe and the rim of the bell from gaining the grating and passing into the house. When such a trap is in a washing-house floor, to carry off the water with which the floor is flushed, it is quite common for it to become blocked by the dirt &c. washed in, and then it is common, in order to let the water away, for servants and others to scrape away the cement from the edge of the grating and lift it a little. The bell is thus lifted out of the water and communication between the house and the drain is made perfectly open. Moreover it requires very little water to fill the trap; some of them hold little more than a teacupful. The consequence is that the evaporation of a small quantity of water will so diminish the amount in the trap that the entrance to the drain is completely exposed, and the seal is no longer effective. Such a trap would, therefore, be the worst possible, where frequent fresh supply of water does not occur, or where the heat is so great that rapid evaporation occurs, as in the floor of a furnace-room. So apt is this kind of trap to become inefficient that it is now universally condemned, and ought never to be used inside a dwelling, or dairy, or laundry.

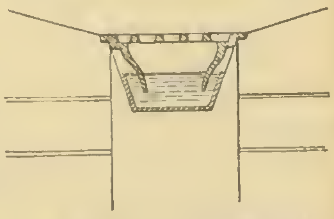

Fig. 290.—Liverpool Bell-trap.

The **Liverpool trap** is another form of the bell-trap, and open to the same objections. Fig. 290.

Ventilation of Traps and Drains is the second condition now invariably insisted on in any system of drainage designed to meet modern sanitary requirements. This ensures the continual removal of foul effluvia from the pipes &c. by a constant current of fresh air. For it is to be observed that efficient ventilation implies not only that there shall be a way of escape provided for foul gas, so that it can never accumulate so as to force the trapping water, but also that an inlet for fresh air shall also be provided, so that there shall be an actual current to remove foul air and keep the atmosphere in the pipes constantly as pure as possible. How are these objects accomplished? Inside the house all traps should have a ventilating pipe, such as is shown in the case of nearly every house-trap in Plate IX^b. The ventilating pipe either itself passes up to open on the roof, or opens into a pipe which is continued to the roof. All outside traps should be constructed on the principle illustrated in Fig. 284. It is evident from these figures that no accumulation of gas can occur in such traps. Fig. 291 illustrates how, with such arrangements, a constant fresh-air current is secured. It represents three water-closets, A, B, and C, on the three floors of a house, discharging into the same soil-pipe, S S. At the foot the soil-pipe is provided with a disconnecting trap T by which it is cut off from the sewer. But if the soil-pipe terminated at X, which it might naturally be supposed to do, there could be no current through the soil-pipe. When, however, the soil-pipe is continued upwards, full size, to open at the roof, then air entering through the trap grating G passes right up the pipe, clearing out all foul air and securing efficient ventilation. In the same way traps connected with wash-hand basins, baths, sinks, &c. should have a pipe connected with a main ventilating pipe open both at the foot and top to secure the same end.

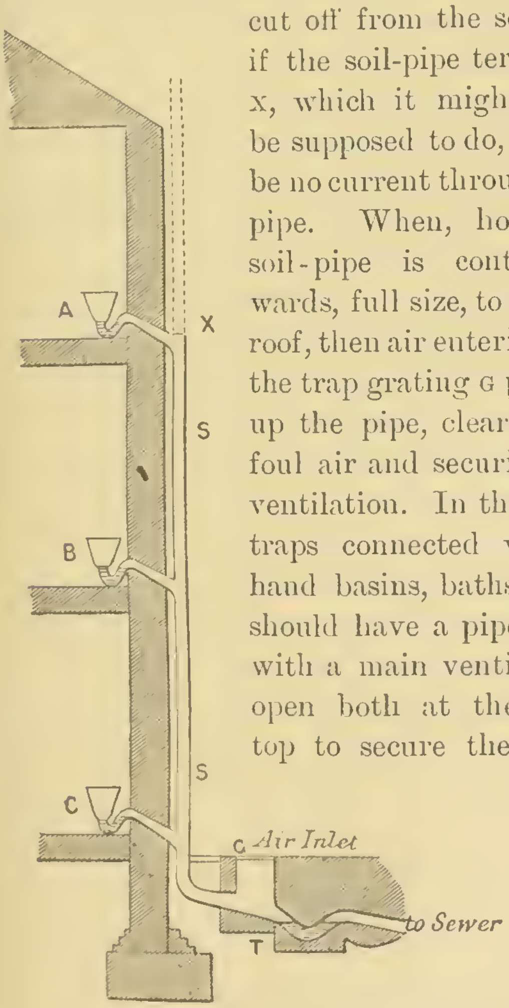

Fig. 291.—Faulty Method of Disconnecting and Ventilating Soil-pipe.

This is further illustrated in *fig. 1*, Plate IX^b.

Drain-pipes, Sewers &c.—Traps, however well devised and ventilated are only one means to the end desired, namely a house free from sewage emanation. One is too apt to think that in a multitude of traps is safety, and to ignore other equally important means of securing proper drainage. Strict attention must also be paid to the drain-pipes, the material of which they are made, the position in which they are laid, the manner in which one length of pipe is connected to another, and in which one drain joins another, and so on.

Material of Pipes.—Pipes inside the house (called **house-pipes** to distinguish from the pipes outside leading to the sewer, to which it is desirable to restrict the term **drain-pipes**, to avoid confusion) are usually made of lead or iron. Lead is very commonly used for greater ease of manipulation. The pipes should, in such a case, be made of drawn lead rather than soldered or seamed lead. Lead pipes for use inside should be $\frac{1}{8}$th inch thick, and should weigh 8 pounds per foot. Junctions should be made by means of wiped joints. Iron pipes are objected to by some because of their rough interior surface giving points of adhesion for particles of soil. When they are used they ought to be of the best quality and of smooth finish, and a porcelain-lined pipe is to be had, recommended for its cleanliness and durability. Iron pipes are somewhat readily corroded; but lead pipes are more easily eaten through by rats or cut by nails, &c. The former are usually 4 or 4½ inches in diameter. They should be coated by Dr. Angus Smith's process, or by the Barff or Bower-Barff process, for the prevention of rust.[1] The thorough joining of such pipes is a matter of some difficulty, requiring careful and skilful plumbing work. The joints of iron pipes are often made inefficient by changes of temperature causing expansion and contraction of the metal and loosening the joint. The junctions should be well caulked and leaded; putty should never be used. Where such a pipe passes down inside a house against a wall, the part of the joint next the wall is difficult of access, and the work is often badly done, sewage gas being permitted to escape directly into the house through the faulty joint. Drain-pipes should be made of glazed earthenware, preferably salt-glazed. Porous earthenware pipes are, on no account, to be used, nor brick-built drains. They are easily broken, and permit leakage into the soil, and then the hot atmosphere of the house will draw the foul air from the soil, the foundations of the house being also constantly damp.

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[1] In Dr. Angus Smith's process, the pipes, heated to 700° Fahr., are immersed in a mixture of coal-tar pitch and linseed-oil heated to 300° Fahr., where they are left till they cool to 300° Fahr. Then they are removed and set to cool in a vertical position. In the Barff process, the iron is carefully cleaned, and is exposed, in a chamber kept at a very high temperature, to the action of superheated steam. The steam is decomposed by the heat, and a deposit of black oxide of iron—magnetic oxide—is produced on the pipes, which protects them from rust, the more effectually the greater the heat to which they were exposed, and the length of time they were exposed to the process.

Mode of Junction of Pipes.—The glazed earthenware drain-pipes should be socketed, so that the end of one section terminates inside the socket or flange of the other. The one pipe should properly fit the other, and the junction should be completed by cement, not mortar or clay. At proper intervals, drain-pipes should be provided with special inlets for inspection and cleaning purposes. Sections of pipe are made with such inspection eyes which pass upward to or near to the surface and are provided with a properly-fitting cover, sealed with mortar or putty. Round these access pipes a manhole may be built provided with a cover, which may be simply a flat stone, with a ring in it, bedded in cement or mortar. It is very necessary to see that drain-pipes are provided with a firm bed. If the soil is a made-up one, in particular, it will readily yield and the pipes may thus become broken or distorted. Where special care is being taken, it is advised to provide a cement bed, along the whole length of the drain to its junction with the sewer, care being taken that at appropriate intervals small cement chambers are built to admit of access for cleaning or inspection. Large-sized pipes should never join smaller ones; and when a junction is being effected between pipes of different sizes it ought to be by means of tapering pipes. The average diameter of drain-pipes is from 4 to 6 inches.

Junctions with drain-pipes should never be effected at right angles; the one pipe ought to pass gradually into the other, so that the current is not interrupted, the entering current having very nearly the same direction as that in the drain that is being entered. For similar reasons sharp turns are to be avoided, with their inevitable slowing of the current and tendency to encourage deposition of sewage matter. Pipes with curves to suit all kinds of turns are now provided, and their use should always be insisted on. Careless and indifferent workmen, to save themselves the trouble of securing such curved pipes, have been too often known to knock a hole in the side of one pipe, through which the end of the connecting pipe is passed, the space being filled up with cement, or not filled up at all.

Drain-pipes should always have a proper fall; the best practice is to allow a fall of 1 inch to each yard.

Position of Pipes.—It is customary for the pipe from the water-closet—the soil-pipe—to pass down inside the house, receiving branches on its way, from closets on different landings, or in the case of tenements, from closets from different houses, and being also joined by the waste from the bath, wash-hand basin &c. It often also receives the waste from kitchen, scullery &c., all the soil and waste from the dwelling indeed passing into the soil-pipe, which ultimately joins the drain at the basement. Now this is a bad system, for if any leakage occurs in any part of its course, if any faulty joint exists, and as already stated the changes of temperature, to which the pipe is subject, are very apt to make the joints leaky in time, the house gets the whole benefit. If there is any defect in fittings connected with the kitchen, scullery &c., the connection of their waste-pipe with the soil-pipe will ensure the entrance of gas into the house. It is, therefore, the first maxim of a sound sanitary system that the soil-pipe is carried out of the house as quickly as possible. It should pass down the back wall of the house. The branch from each closet should pass as directly as possible through the wall to join it, and in this way it can receive as many branches as may be deemed necessary. There ought to be no difficulty, in constructing a house, in placing the water-closet against the wall of the house so that there need be no long branch pipe to connect with the main. If any leak occurs in the course of the pipe, the sewage gas escapes into the open air, where it can do less damage, unless in the event of a window being in the immediate neighbourhood. The soil-pipe should be carried up to the roof, its full diameter, to act as a ventilating pipe. With such an arrangement, the closet basin having a trap beneath it, all fitting being properly made, and the soil-pipe passing outside through a disconnecting trap (Fig. 284), there should be no risk whatever from human excreta. If in addition to closet basins, the house is provided with a urinal, it also would be trapped inside and its discharge pipe would join the soil-pipe. If possible the soil-pipe should not pass near to windows, lest gas from a leaky joint should enter the house by the open window.

All other waste-pipes, pipes from bath, basin, sink, scullery, wash-house &c. should enter a separate pipe, having nowhere any connection with the soil-pipe. It also should pass down outside the house, receiving the various branches on the way, each branch having a separate trap upon it, just underneath the bath, or basin, or sink, as the case may be. This waste-pipe also should be disconnected from the drain by a disconnecting trap. If the soil-pipe is trapped at the foot, the waste pipe could terminate in the open air, discharging its water into the same trap through the grating, or the pipe might open into the trap, just beneath the grating, the soil-pipe opening at a lower level. If, however, the ventilating trap on the soil-pipe is at some distance from the house, as is desirable, the best arrangement would be to have a trap for the wastes alone, such as the Hart trap (Fig. 285), into which also rain-water pipes from the roof could discharge, all opening in the air over the grating or immediately under the grating.

Where it is at all possible to avoid it, drain-pipes should never pass under a house. If they leak, the house gets the full advantage either because of the direct escape of sewage gas, or because of effluvia from the soaked soil. The soil-pipe and waste-pipes should always connect with the drains, *outside of the house*, and if it is necessary for the drain to pass from back to front of the house, it should be carried round outside. Where it is unavoidable that the drain pass below the house, the utmost care should be exercised in its laying and jointing. It ought to be laid in cement, and at appropriate intervals access chambers, provided with air-tight covers should be provided, so that whenever necessary the drain could be inspected or cleaned, without unnecessary disturbance. It is not unusual to find a drain altogether outside of a house and yet practically opening into it at the basement, because of a rain-water pipe carried under the floor space to join the drain. As the pipe is only to carry rain-water, probably no great pains have been expended on its junctions, and perhaps it joins the main drain directly, without the intervention of a trap, with the notion of serving as a ventilating pipe for the drain. The result of the whole arrangement is that the warm air of the house sucks sewage gas, direct from the drain, through the defective joints of the pipe, as it passes beneath the basement, and the drain is literally being ventilated into the house.

Common Defects in House Drainage.

Defects in the Soil-pipe.—It has already been noted that it is a serious error to carry the soil-pipe through the interior of the house, if it is at all possible to carry it outside. It is often made to pass through rooms, pantries, larders &c., which ought not to be permitted. It is frequently not ventilated at all, or is ventilated only by a pipe of much smaller diameter than the soil-pipe itself. Sometimes the rain-water pipe is made to serve as a ventilating shaft for the soil-pipe, and it may terminate at the eaves in close proximity to a window, through which its foul air may be discharged into the house. If we summarize defects of workmanship in the kind of pipe used, in the making of joints &c., and the dangers arising because of want of disconnection between the soil-pipe and the main drain, defects already incidentally alluded to in noting the correct methods of arranging for the soil-pipe, there remains yet one frequent source of mischief. The cistern from which the flushing water for the closet is derived is also frequently the same cistern from which water for the domestic purposes of the household is obtained. The cistern is provided with an overflow-pipe, and this pipe is not uncommonly connected with the soil-pipe, so that the soil-pipe may actually be ventilated into the water, which is subsequently used for cooking and drinking purposes. The closet ought to be provided with a cistern for itself, and its overflow-pipe ought to be made to discharge into the open air.

Defects connected with Waste Pipes.—Waste pipes are very frequently made to enter the soil-pipe untrapped, or they join a rain-water pipe, which has a direct connection with the main drain. The rain-water pipe, in such a case, is supposed to act as a means of escape of foul air from the drain, but the arrangement almost ensures the entrance of gases from the drain into the house. Moreover rain-water pipes are quite usually carried down inside a house between the outer wall and the plaster, and if their joints are defective, as they almost always are, not only is foul air drawn into the house, but in the case of storm, when the pipes are running full or may be partially blocked, water also escapes between the walls.

Defects to be looked for in drains are numerous. Improper—porous—material is employed; joints are badly effected; sometimes one pipe is simply shoved into another, no cement being employed; if a piece of rock is being crossed in the bed of the drain, a lazy workman may chip off a piece of the pipe socket to avoid chiselling out a piece of the rock; a hole may have been driven into the pipe for inspection purposes, and subsequently covered only with a slate; the soil may have subsided causing cracking of the drain; or the house may have settled and the drain may have been crushed, for want of a protecting arch where it passed through the wall. In all these ways material may be permitted to soak into the soil, the emanations ultimately reaching the house.

The soil-pipe, drain, and main sewer may be in direct connection with one another, no trap intervening.

What has been said as to the means of preventing drains polluting a dwelling and the usual departures from sound methods is illustrated by the two following figures.

How a House Ought Not to be Drained is illustrated in Plate IX^a, which exhibits a plan of a self-contained house or villa. *Fig. 1* shows the ground-plan and *fig. 3* a section. The reference letters are the same in both. D D D D is the main drain which passes from front to back *underneath the house.* It is partly made of fireclay pipes, and partly a brick-built drain. It terminates in a cesspool C built of brick, which is provided with a dipstone. The faults of this arrangement are: (1) The drain runs under the house and the house gets the full benefit of any and every leakage that occurs; (2) the earthenware pipes forming the front part of the drain are simply pushed into one another with no properly cemented joints; (3) the curve in front is not effected by curved pipes but by straight pipes, the flow from one pipe to the other will be impeded, and the drain is apt to be blocked; besides, the leakage will be very great; (4) the walls of the drain throughout are porous and leakage into the soil will occur all along, sewage emanations being drawn from the soil into the house owing to its warmth; (5) the cesspool acts simply as a retainer of foul putrefying material, leakage also occurring and being meant to occur from it; (6) the dipstone does not impede the backward passage of foul air, for foul gas is generated on the house side of it as well as on the sewer side, and the dipstone is so placed as to be perfectly useless (see *fig. 3*). The house pipes are thus in direct connection with the sewer; (7) the drain has no proper fall; (8) the drain passes through the foundation walls (at F, *fig. 3*) without any precaution to prevent damage through subsidence.

From the main drain branches pass off to various apartments. Beginning near the cesspool, **the first branch, 1**, is partly a brick-built pipe passing in under the washing-house floor, and ending under a grating (G, *fig. 1*) for the removal of surface water. The pipe from the tubs passes directly into this branch. The faults here are threefold: (1) This branch passes directly into the main drain and thus leads off sewer gas straight into the house; (2) the wash-tubs and surface grating communicate directly with the branch, untrapped, and (3) the mode of junction of the pipe from the tubs with the branch is one which tends to encourage deposit occurring in the branch. The **second branch** from the main drain is a rain-water pipe, 22′ 2″ (*fig. 3*), which passes up the end of the house and has a branch opening under the window W, for running off the rain-water from the roof, R, while it terminates at the eaves at 2″, near the upper part of the same window. The fault here is serious, for this pipe being in direct connection with the main drain acts as a blow-off for foul gas which it discharges beneath and in a line with the top of the window. Any time the window is open sewage gas will gain access to the house from it.

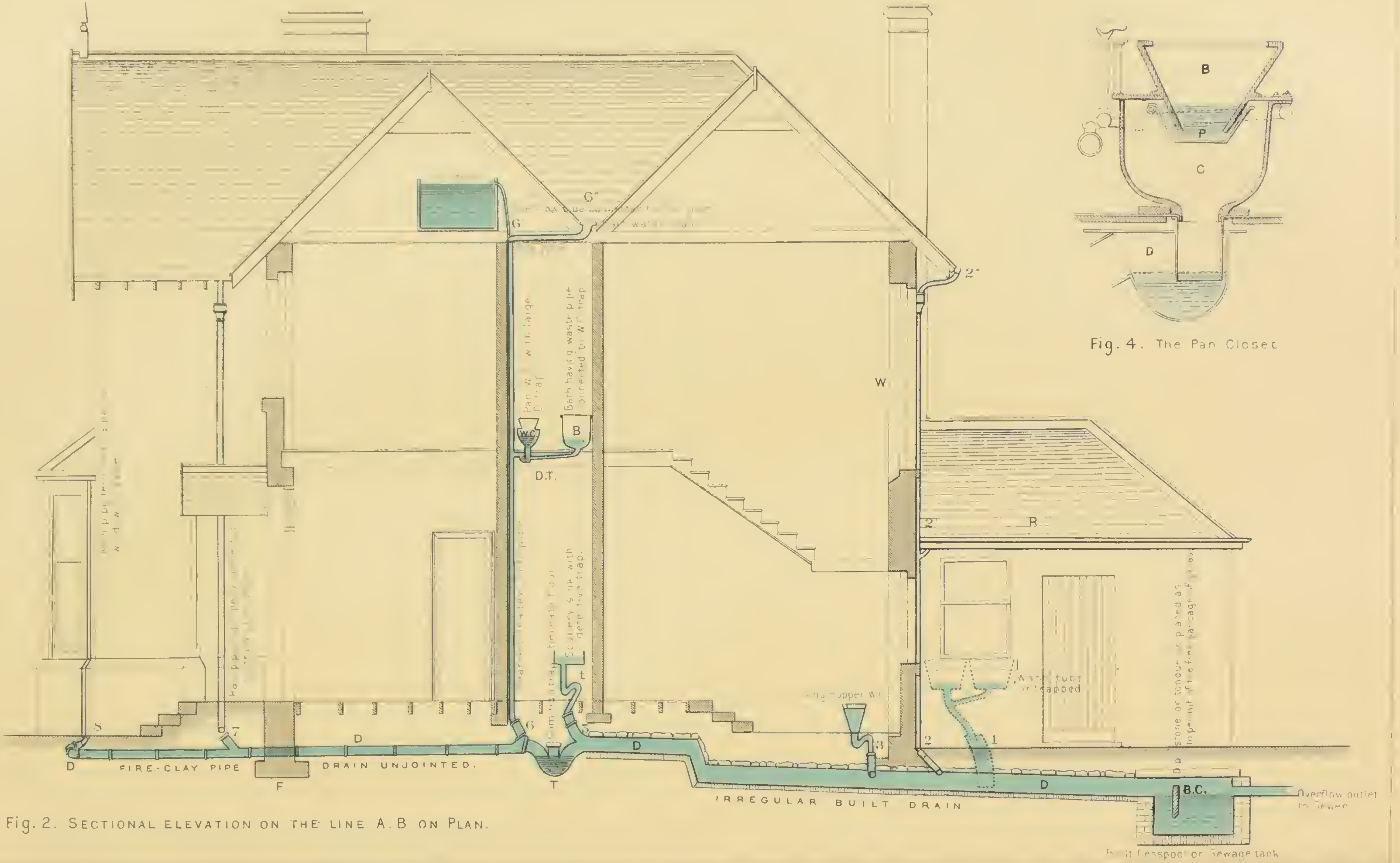
Branch 3 goes to the long hopper closet, a bad form of closet. (See p. 717.) It is faulty besides (1) in that the trap is not ventilated, and (2) the pipe from the w.c. enters the drain in a direction against the current (see *fig. 1*), and thus excreta will always be retained in the pipe.

Branch 4 (shown in *fig. 1*, though not seen in *fig. 3*, because of the position of the section) is the waste-pipe from a bed-room basin. Its faults are (1) its direct connection with the drain causes it to lead off sewage gas into the bed-room; (2) leaky joints make it a more certain conductor of foul air into the house; (3) it is ventilated by a pipe opening into the flue of the bed-room fireplace. In warm weather, when no fire is on, and when the atmosphere of the room is cooler than that of the outside air, there will be a down current of air into the room, and this will carry with it the foul air from the pipe.

Branch 5 leads to a scullery sink. (1) It also is in direct connection with the drain; (2) the only protection against the entrance of foul air from the drain is the leaden trap (*fig. 3*); but it has been pulled out of shape by the workman when the joint was made, and the water no longer stands high enough to act as a seal; (3) the scullery sink is so placed that the servants' back is always to the light; the sink is, therefore, dark.

Branch 6 is the soil-pipe. It is connected (*fig. 3*) with a pan-closet and receives also the waste from the bath (B), while it is continued to the roof to act as a ventilating pipe, and also as a rain-water pipe (6″) for the roof, while it receives the overflow pipe (6′) from the cistern, this pipe being connected merely by a slip-joint. The evils of this arrangement are enormous. (1) The soil-pipe is practically unventilated for no fresh air can enter the main drain to sweep up the pipe; (2) The w.c. is of the worst pattern, the pan w.c. (see p. 717); (3) the bath waste

PLAN AND SECTIONAL ELEVATION OF VILLA.



B
P
C
D
G"
G'
W
2"
2
R
W.C
B
Pan W.C. with large D trap
Bath having waste pipe connected to W.C. trap
D.T.
Scullery sink with defective trap.
t
6
5
T
D
S
7
D
F
3
Hopper W.C.
Wash tubs untrapped
1
stone or tongue prepared as to permit of the free passage
B.C.
Overflow outlet to sewer
Built Cesspool or Sewage tank
FIRE-CLAY PIPE
DRAIN UNJOINTED.
IRREGULAR BUILT DRAIN

Fig. 4. The Pan Closet

Fig. 2. SECTIONAL ELEVATION ON THE LINE A.B ON PLAN.

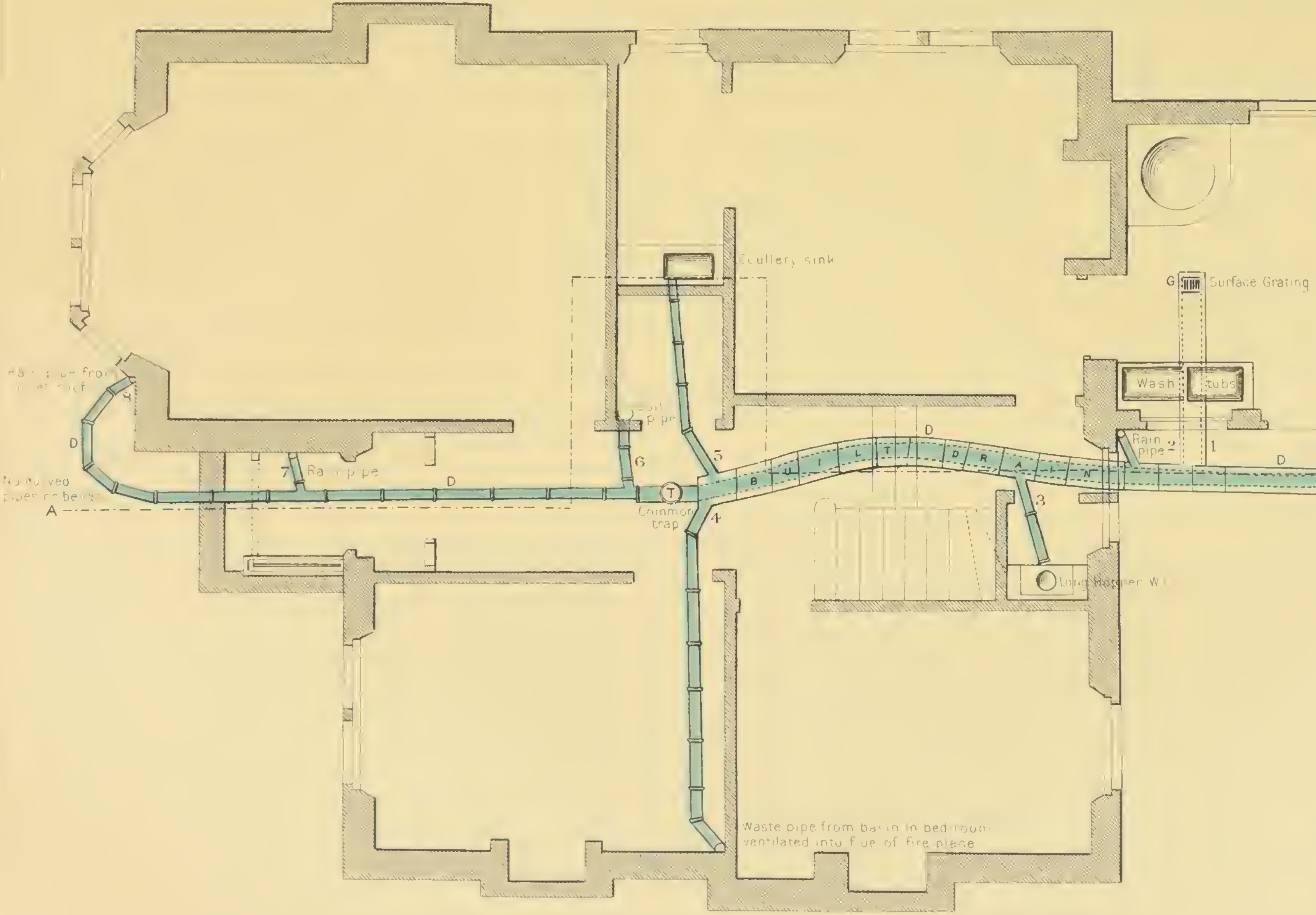


Fig. 1. GROUND PLAN.

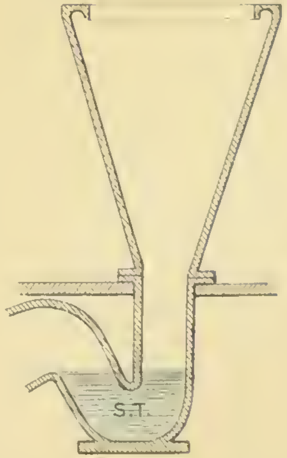


Fig. 3. The Hopper Closet

enters the D trap of the w.c., which is certain always to be foul, and thus the waste-pipe simply leads off the foul air of the trap into the apartment; (4) it is a great mistake for the continuation of the soil-pipe to be made a rain-pipe, the risks of blocking being serious; (5) the water of the cistern is certain to be polluted by gas escaping up the overflow pipe, which also secures that the soil-pipe shall be ventilated, not into the open air but into the air of the house.

The trap T is an excellent illustration of the foolish way in which traps are sometimes employed. It is placed under the house floor, so that it is impossible to make it a ventilating trap. It simply acts as a detainer of the excreta coming down the soil-pipe, so that instead of that material being swept out of the house as quickly as possible it is detained for a longer or shorter period in the trap, and it prevents the possibility of any current of fresh air passing through the drain.

Branch 7 is for a rain-water pipe, but the pipe falls short of the entrance to the drain, and a constant soakage of the soil occurs from water missing the drain, while sewage gas pours into the soil from the open drain.

Branch 8 is a rain-water pipe, defective because (1) of its direct connection with the drain, and (2) because it terminates below a window in the gable.

How a House Ought to be Drained is illustrated in Plate IX^b. The upper figure shows the ground-plan, the lower a section. It represents the same villa as Plate IX^a. The chief features of the system there shown are these: I. The drains are all outside the house, and all house pipes are carried outside the walls as speedily as possible; II. there is no pipe for the removal of waste water in direct connection with any drain; III. the soil-pipe is kept entirely separate from the rain and waste pipes, the two systems being disconnected from one another by means of ventilating traps.

Let us study these figures to understand how these things are managed. We shall begin with the outfall to the main sewer O, which is a 6-inch glazed earthenware pipe, with joints caulked and cemented. The first thing to notice is the ventilating trap (V T^1), a 6-inch trap of the Buchan type (Fig. 284). This trap at once disconnects the whole of the house drainage from the common sewer. Entering that trap there are two drains, S D^1 and S D^2.

S D^1 is a glazed earthenware pipe drain, 6 inches in diameter, joints being caulked and cemented. Communicating with it are three different house-pipes, namely the soil-pipe from the upstairs w.c., the waste-pipe from the scullery sink, and the rain-water pipe, carrying off the rain-water from the roof and receiving also the waste water from the bath. These arrangements are shown in dotted lines in *fig. 3;* in dotted lines because a section such as is represented in the figure would not actually display them.

Taking the soil-pipe first, observe (1) that it passes right up to open above the roof, tapering out as it opens (S P, *fig. 3*); (2) that the w.c. is trapped (T) before it enters the soil-pipe, and that the trap has a pipe (V) passing off its highest outer point into the soil-pipe so that the air current through the soil-pipe prevents any accumulation of gas on the soil-pipe side of the trapping water; (3) that no waste or rain pipe enters the soil-pipe; (4) that the w.c. is of the Bramah type; and (5) that the w.c. has a special cistern (C^2) for flushing water, and has no connection with the cistern (C^1) supplying the house with water for domestic purposes. Observe lastly that the soil-pipe is continuous with a drain which has no direct connection with any other house-pipe, all waste or rain-water pipes in communication being cut off from direct connection by ventilating traps. It should be noted that apart from the trap connected with the w.c. there is no trap whatever on the soil-pipe or the drain it joins, till we reach the disconnecting trap V T^1. The result is that air entering the inlet grating of V T^1 (see *fig. 1*) passes right up the drain S D^1, and escapes at the top of the soil-pipe above the roof, so that there is a constant current of fresh air through the drain and soil-pipe. This is a preferable arrangement to having a ventilating trap on the soil-drain, at the point marked X, for example, near to some of the house windows, provided the length of drain before the ventilating trap V T^1 is reached be not too great. If, however, this distance were great, say more than 30 feet, a ventilating trap might be interposed sooner, provided it were out of the way of windows. Next let the scullery arrangements be noticed. The sink (S) is brought over to the window space (*fig. 1*). Its waste-pipe W P is trapped, and opens outside immediately under the grating of a grease-box (G B, *figs. 1 and 3*), the outflow from which joins the soil-drain.

Thirdly, the rain-pipe from the roof, R P, is disconnected from the drain by a Hart trap, H T (see Fig. 285). This rain-water pipe receives the waste from the bath B, the waste-pipe being trapped (T) before it enters the rain-water pipe (see *fig. 3*).

Returning to the ventilating trap, V T^1, let us follow the drain, S D^2. It is a 4-inch glazed earthenware pipe. (1) It passes straight into the servants' w.c., which is a wash-out closet, and (2) it is continued, outside the house (S P^2, *fig. 3*), right up to open above the roof as did the other; (3) the pipe from the w.c. is trapped, and the trap has a ventilating pipe, T, leading into the soil-pipe. This closet is also supplied with a separate cistern.

This drain (S D^2) receives two main branches, one opening on the right, the other on the left (*fig. 1*). A very short way on, however, each of these branches is cut off from direct communication with the soil-pipe drain by a ventilating trap, V T^2 and V T^3. The right branch has two divisions, one (1) is a pipe removing waste water from the washing-house tubs and washing-house floor, and the other (2) carrying rain-water from the washing-house roof. The waste from the tubs is, however, trapped just under the tubs (see *fig. 3*), and the pipe running off the water from the floor communicates with the floor through a syphon trap (S T, *fig. 1*). Moreover, the trap of the tubs is supplied with a 1½-inch ventilating pipe carried to the roof. The rain-water pipe has no trap apart from the ventilating trap V T^2, and thus a free current of air from the inlet grating of that trap is allowed right up the rain-water pipe.

The branch, R D, to the left (*fig. 1*) is cut off from the soil-pipe drain, S D^2, by the ventilating trap V T^3. It receives two rain-pipes from the roof R P^1, R P^2, which are not trapped at their base, and it also receives a waste-pipe, W P. This is the waste-pipe carrying off the waste from the bed-room basin, which in Plate IX^a is shown as branch 4 and was ventilated into the bed-room flue. It is in Plate IX^b continued to the roof as a rain-water pipe. In the bed-room the waste would be trapped under the basin, and from the trap a ventilating pipe would be carried to join the upward continuation of the pipe. For additional security this combined waste and rain pipe opens at its base into a Hart trap (H T) (*fig. 1*, Plate IX^b).

To this description of the two plates one need only further add that the soil-pipes, in the properly constructed drainage system, are all heavy cast-iron pipes, with caulked and leaded joints, that the inside traps are made of drawn lead, the pipes ventilating the traps are drawn lead pipes, 1½ inch in diameter, any junctions being effected by means of wiped joints. The drains, as already noted, are all of glazed earthenware with joints properly cemented.

Plate IX^a shows also the space for coals and ashes opening into the washing-house, and thus in free communication with the air of the house. Plate IX^b shows this remedied by the communication with the house being built up, and direct openings to the outside being substituted.

Testing Drains.—There are several methods adopted for determining the soundness of a drainage system. One of these methods consists in pouring oil of peppermint, or other volatile strong-smelling substance, mixed with hot water, down the soil-pipe from its opening above the roof, and searching in and outside the house for any place where the smell of the oil indicates a fault. Sulphur may be burned on the house side of the disconnecting trap; and if any escape into the house, its presence will be detected by the smell, and the existence and position of the leakage will be thus indicated. The common method in use is the smoke test. Oily waste, sometimes sprinkled with sulphur, is burned in a covered box communicating with the drain, or if the system is trapped, with the house side of the trap. By means of a fan turned by a handle, or a small bellows fitted to the apparatus, air is driven into the box and the smoke driven into the pipes. If any leak exists the smoke will readily gain access to the house and be detected by the smell. When the pipes are filled with the smoke so that it issues from the openings above the roof, these are usually blocked, and the air continues to be forced into the pipes. Smoke is in the pipes at pressure and a leak is readily detected. The doors and windows of the house should be kept closed, to confine any escaping fumes to the apartment into which they enter, so that the locality of the leak may be more readily found. Another method consists in blocking the drain at some point outside of the house or at the outflow end of the trap, and running water into the pipes from sinks, baths, closets &c. till the pipes are full. The pipes should remain full, but if they leak the level of the water will fall, and the amount of leakage may be estimated by the water it is needful to keep running to maintain the level. The appearance of wetness in walls &c. will indicate where the leakage is occurring.

Flushing of Drains.—To keep drain-pipes as clean and free as possible from deposit, frequent flushing with water is needful. The larger the body of water with which this is done the better. A constant dribble of water is not nearly so effective as an occasional rush of a large quantity.

In all houses there is a continual flow of waste water from wash-hand basins, baths, rain-water pipes &c. which is not very effective for cleansing purposes, as it ordinarily is allowed to escape, but which if collected and allowed periodically to escape in a body into the pipes would flush them very thoroughly. Such water might be collected in a tank in connection with the drains and might be supplied with a self-acting arrangement, which, when the tank was full, would cause the water to be discharged into the pipes till the tank was empty, when the communication would be closed till the tank was again full. A considerable number of tanks have been patented for this purpose, of which Field's is one of the best known. It is illustrated in Fig. 292. It is a tank fixed underground, the feed of which may be supplied with rain-water, or bath waste, or by means of a tap direct from the main. Towards one end is fitted a syphon arrangement, DD, one limb of which is long and opens below into water of the trap, F. This limb rises to the height of the top of the tank and then bends over, passing down into the tank to open not far from the bottom. As the inflowing water rises in the tank, it also rises in the inner limb of the syphon till, when the tank is full, it reaches the bend at the top, over which it passes. The syphon action is thus automatically started and the water continues to flow out by the syphon till the water in the tank is brought down to the level of the opening of the inner tube. The tank is in short rapidly almost emptied, and the body of escaping water effectually flushes the drain. As soon as the water in the tank falls below the level of the opening of the inner tube, air enters, and the syphon action stops. The tank again begins to fill and the water continues to rise, till the syphon is again set in action by the water reaching the level of the bend of the syphon. Beyond the trap the outflow pipe enters the drain, G, and the trap prevents the backward passage of sewage gas into the tank.

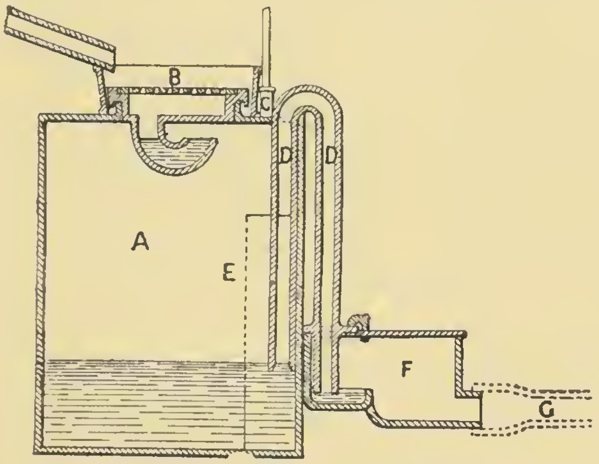


Fig. 292.—Field's Flushing Tank.

A, Tank. B, Trapped inlet. C, Ventilating pipe. D D, Syphon. E, Strainer for grease &c. F, Discharging trough. G, Outlet to drain.

It is now necessary to make a few references to some of the interior arrangements for the disposal of waste.

The Water-closet first of all demands our attention. The old form of water-closet, now universally condemned but still to be found in houses, is shown in Plate IX^a, *fig. 4*. It is placed here as a useful example of defects to be avoided. It is called the **Pan Closet**. The basin, B, is the part visible, the other portions being concealed beneath the seat. At the outlet of the basin is the pan, P, lowered by raising the handle, by which means also the inflow of water is occasioned from the cistern above, which washes out the soil. The basin opens into the container C, and that opens, by the pipe shown, into the D trap, which again leads into the soil-pipe. Now the inside of the container, as is evident from the figure, will be continually coated with excrement splashed up upon it, which no amount of flushing can remove. The D trap is also certain to be constantly foul from the same cause. Thus the trap and container are always full of foul air, delivered into the house every time the handle is pulled up. It is the shape of the closet which makes it bad. It does not matter of what material it is made, it is not possible to keep it clean.

The chief thing to be desired then in a water-closet is a form which, by its very shape, guarantees the effectual scouring off from every part of it of every particle of adherent excrement. The pipe leading from the tray or safe for carrying away any water that may overflow is usually made to open into the trapping water, and thus it ventilates the trap into the house. It has been found opening directly into the soil-pipe, and thus leading off foul gases from the soil-pipe into the house. It ought however to be taken through the wall to the outside, being provided with a flap-valve to prevent entrance of cold air.

The **Hopper Closet** shown in Plate IX^a, *fig. 2*, is another form condemned for a similar reason: it does not admit of the flushing water cleansing every portion of its interior, and a great deal of material is likely to be retained in the syphon-trap shown below S T.

Wash-out Closets.—There are now in the market many forms of water-closets which avoid the defects which have been noted. They are commonly made of some kind of earthenware, the basin and the trap beneath being all in one piece. *Fig. 2* of Plate IX^b, shows one of these kinds where T is the trap, S leads into the soil-pipe, and V is a ventilating-pipe. By means of this pipe if the soil-pipe communicates with a disconnecting trap, and the soil-pipe is open to the roof there is a guarantee of a constant current of fresh air preventing any accumulation of foul air in the trap.

The **Valve Closet** or **Bramah Closet** shown in Plate IX^b, *fig. 4*, is one which meets with commendation. The figure also illustrates how it ought to be connected with the trap T. The safe placed on the floor to receive any water which escapes over the basin, should be provided with a waste-pipe, passing directly outwards and opening in the outer air. The external opening ought to be provided with a flapper to prevent the inrush of cold air.

Flushing Water.—A good form of closet being secured and properly set up, the next thing is to see that a full supply of flushing water is provided. This depends upon the size of the service-pipe. The supply ought to be sufficient to fill the overflow-pipe O (*fig. 4*, Plate IX^b) every time the handle is drawn.

The Connection of Water-closet and Cistern demands attention. The cistern is certainly provided with an overflow-pipe, and the important question is where does that overflow-pipe go to. It is probable that it enters the soil-pipe, or the water-closet trap, or passes directly to the drain itself. In such an event the waste-pipe is simply tapping the foul air of the drain, trap, or soil pipe, and conducting it into the house. It may connect with the waste-pipe of the bath, wash-hand basin or scullery sink; and to all of these connections there is the same objection. In cases where the house is not supplied with water for domestic purposes direct from the main, but where the same cistern supplies the water to be used for cooking and drinking purposes, the evil is a double one, for the water is being contaminated by the sewer gas, and the household is not only breathing a polluted atmosphere but is drinking polluted water. The waste-pipe ought in all cases to pass to the outside and open in the open air. No cistern supplying water for domestic purposes should be connected with any water-closet, or other arrangement for the removal of excreta. Where the water supply is provided from a cistern, the closet ought to be supplied by a separate cistern, which, if it must be supplied from the main cistern, may be by a disconnecting method which shall guard against any contamination of the drinking water.

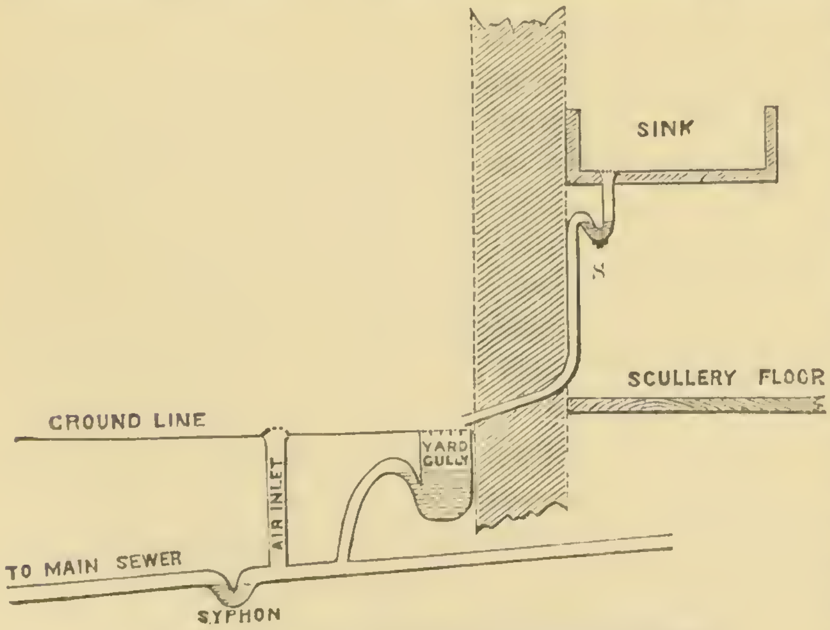


Fig. 293.—Arrangement of Waste-pipe from Scullery Sinks.

Sinks.—The sink requiring special attention to be paid to it is the scullery or kitchen sink, for into it there passes a large quantity of greasy material, which readily adheres to the inside of the pipes, to the sides of the traps, and to the walls of the drain, and which in large establishments will clog up the drains sooner or later. For such large establishments a grease-trap is necessary, a trap fixed outside the house, into which the pipe from the sink enters, and of which the outlet-pipe to the drain is so arranged that the grease is retained and collected for periodic removal. Concerning grease-traps Eassie says they are required, "never in cottages, seldom in small houses, sometimes in the larger dwellings and villas, where cook and scullery-maid reign below stairs, and always in houses where the number of servants outnumbers the family. This is a very skeleton definition, but it is all my space will allow. Where a grease-collection trap is necessary, unless that accommodation be rendered, the underground drains will choke up, and necessitate their being opened up and cleaned out. The need for a grease chamber is enhanced when the culinary utensils are scoured out with sand at the scullery sink, and if a chamber be not provided, the drain will clog all the sooner, as the sand does not get to the sewer, but becomes embedded in the grease." Where a grease-collection trap is not necessary, it is needful only to recal what has been already said on p. 713, that the sink waste-pipe should not open into the soil-pipe but have a separate house-pipe,

PLAN AND SECTIONAL ELEVATION OF VILLA.

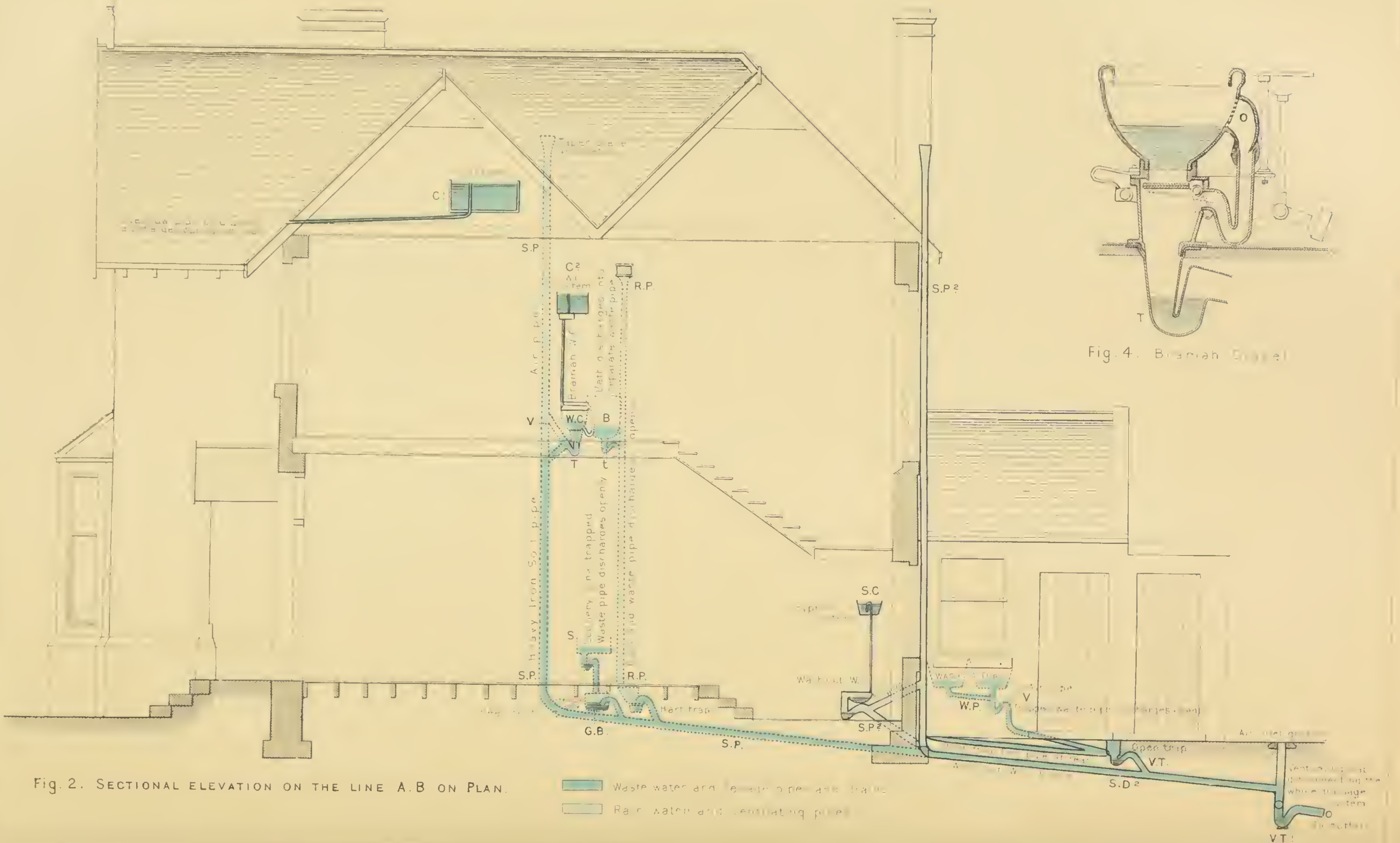

C¹
S.P.
C²
Cistern
R.P.
Air pipe
Bramah W.C.
Watr discharges into separate waste pipe
V
W.C.
B
T
t
open
Heavy Iron Soil pipe
Scullery sink trapped
Waste pipe discharges openly
Rain and waste pipe discharge open
S.
S.P.
R.P.
Hart trap
G.B.
S.P.
S.P.²
S.C
Wash ht. W.
S.P.²
W.P.
V
V.T.
Open trap
S.D²
VT¹
O
Waste water and [illegible] pipes and drains
Rain water and ventilating pipes

Fig. 2. Sectional elevation on the line A.B on Plan.

Fig. 4. Bramah Closet

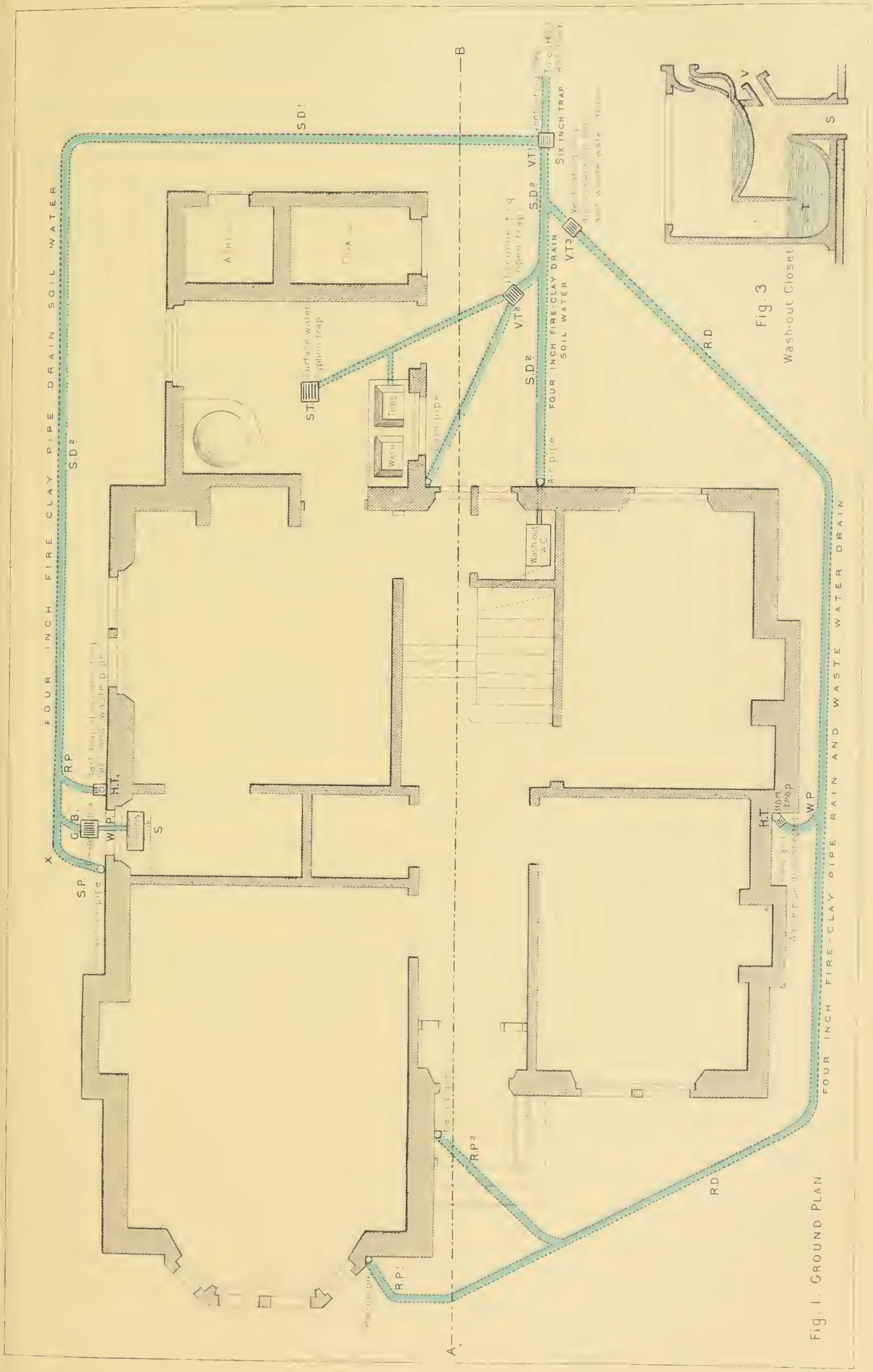


Fig. 1. Ground Plan.

Fig. 3
Wash-out Closet

that that pipe should open in the open air either over or immediately under the grating of a disconnecting trap, preferably of the gully form, by which any sand and other solid waste may be intercepted, lest its entrance into the drains obstruct them. Such an arrangement is shown in Fig. 293.

Bath and wash-hand basin wastes are similarly treated, and all are trapped within the house by the syphon trap (s) shown in Fig. 293. The form of syphon for sinks connected with kitchen, scullery, wash-house, &c. ought to be the access-syphon, illustrated in Fig. 294. The screw in the bottom of the trap permits of opening the trap for the removal of any retained solids which cannot be washed away readily.

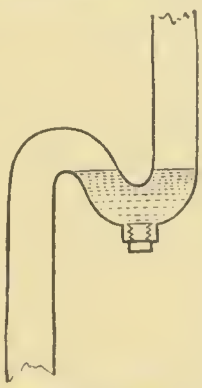


Fig. 294.—Access-syphon.

Grease Traps are shown in Figs. 295 and 296. Owing to the depth of the lip of the trap, the layer of floating grease is prevented passing into the drain, and can be removed at intervals.

It has been questioned whether, provided the sink waste is provided with a system separate from the soil-pipe, and is properly disconnected from the drains, as shown in Fig. 293, any trap immediately under the sink is advisable, and whether it is not rather objectionable from its risk of retaining decomposing materials, grease, soap-suds, and the like. If the waste-pipe were to pass directly through the wall and were very short, no such trap might be needed, but it is needed where the sink is any distance from the place where the waste-pipe opens, and where the waste-pipe is consequently of some length. For the grease, soap &c. retained in the pipes, occasion very objectionable smells, which would be drawn into the house by its warmth. Where the pipes are of some length, indeed, not only is the trap desirable, but it is also advised that a ventilating pipe be led off from the outer side of the trap and be carried to the roof, so that a draught of fresh air is passed through the pipe to keep the air sweet.

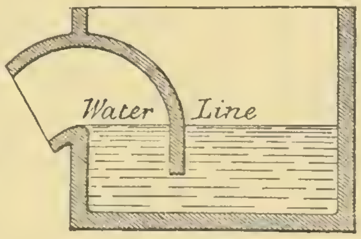


Fig. 295.—Grease-box.

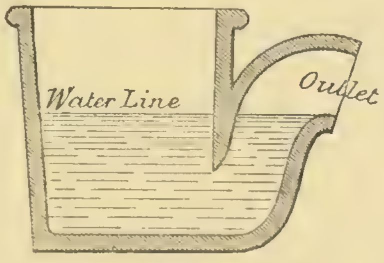


Fig. 296.—Grease-box.

Drainage and Water-supply.—Where the water is supplied from mains there is little risk of pollution from drainage. Care ought, however, to be taken that the service-pipes are not in proximity to the drains, and hot-water pipes ought not to pass through the house alongside of cold service-pipes, causing the heating of the cold water. Attention ought to be given to the position of the cistern provided in connection with boilers for heating water for domestic purposes. Such cisterns are usually placed in out-of-the-way corners, covered in and never examined as to their cleanness. It is too common, according to Eassie, to find it placed in the darkest corner of the commonest stowaway cupboard, with its overflow pipe connected with the drain. "On one occasion," he says, "in a large town house in the west of London, the servants complained that the hot water drawn from the tap at the kitchen jamb tasted badly, and was of the colour of weak tea, which was no wonder, for an exploration of the feed cistern in the cupboard led to the removal of several basins full of drowned black beetles, in all stages of dismemberment."

Whenever the water-supply is obtained from wells, great precaution must be taken that the water is not contaminated by sewage before it reaches the house. Collections of dust, refuse, and rubbish of various kinds in the neighbourhood of the well are certain to lead to its pollution. For the water from the heap percolates into the soil and in due time reaches the water. Cesspools near the well are specially to be guarded against. Leaky joints in the drains, which permit the escape of sewage, are also a frequent cause of contamination. If any of the drain-pipes, instead of being of glazed earthenware, are made of porous material, leakage into the soil occurs, and the water-supply of the well will get a full share.

Cisterns.—The water-supply of the house, when derived from a well or a stream, may be pumped up into a cistern in the house, or led thither by gravitation if the source be higher than the house. In such an event the cistern exposes the water to pollution, supposing it may have escaped previous contamination. Cisterns of sawn slate are to be preferred. Those of stone or brickwork cemented inside are also cleanly and useful. Galvanized-iron cisterns are unobjectionable. Wooden cisterns lined with lead are common. The risk of contamination of the water with lead has been spoken of on p. 642. An insoluble salt of lead is soon formed which coats the metal and prevents any such poisoning of the water. This should never be scraped off. When the cistern is cleaned, and every kind should be periodically cleaned, at least once a year, a scrub with a hard brush is all that is necessary. Cisterns of wood only should never be employed, because of their certainty to decay and because they afford material for the growth of low forms of vegetable life. Zinc-lined cisterns are also objectionable. When the cistern is lined with lead, if the water has been retained in it for any time unused, through the house being shut up for example, the standing water should be run off and a fresh supply allowed to enter. Indeed in every case this should be done.

Cisterns should never be inside the roof space of a house, but whenever possible in the open air. They ought to be covered but also ventilated. The trouble of cisterns outside is their liability to frost. This may be greatly diminished by a proper lining of wood, or by a surrounding space filled with saw-dust, or by a lining of inodorous felt. The overflow-pipe should open directly into the open air.

Dry Methods of Removing Excreta.

It is often not possible to remove excreta from dwellings and towns by water carriage, either because the water is not at hand, or because there is not sufficient fall for a due outflow or for other reasons. Even where water carriage is possible the pollution of streams and rivers, which it usually involves, makes it desirable to find other means. Various other methods of removal have therefore been suggested and adopted. The refuse solid and liquid may be received in tanks and boxes and these may be daily removed and their contents applied as manure to land. The land must be at some distance from dwellings, however, and in the case of large towns the expense of collection and cartage becomes great.

The Dry System of removal consists in mixing the excrement with dry earth, ashes, or other material, which absorbs moisture, delays putrefaction, and prevents smell. The mixture is then applied as manure to land. It is necessary in this system that slop water, waste water from sinks &c. be excluded and removed in some other way. For schools, country houses, villages and small towns, it is a convenient and desirable method, under certain conditions. These are that sufficient of the mixing material be provided, in a perfectly dry state, to cover up the excrement and absorb the watery portions, that the mixture is frequently and regularly removed, that the closet is in a position as separate from the dwelling as possible, and that it as well as the place for the pan, pail or other receptacle is properly ventilated.

Moule's System is the proposal of the Rev. Henry Moule, by which dry earth is mixed with the excreta. The absorbing power of dry earth is very great, and the mixture is quite inoffensive. The apparatus required for this system consists of a pail to receive the excreta, and of a hopper which holds the dry earth. The arrangement is such that when the handle of the closet is pulled a proper quantity of earth is thrown into the pail.

Charcoal or various deodorizing substances may be substituted for the dry earth. The earth after removal may be prepared for use again by allowing the organic matter to become destroyed by putrefaction and driving off the moisture by heat. Fine dry cinders may also be employed.

In **Morrell's Arrangement** cinders are thrown upon an opening leading to a sieve placed in connection with a closet. The fine ashes pass through the sieve and are retained till by a movement of the seat of the closet a quantity is thrown upon the soil, the larger ashes pass over the sieve to a pail placed below.

The **Goux System** provides a tub "say 16½ inches high and 20 inches at its greatest diameter. Upon the bottom of the tub are placed 3 or 4 inches of refuse, such as new stable-litter, loft sweepings, stack bottoms, ferns, shavings, saw-dust, shoddy, flax-dressings, spent tan, or hops, or the various waste materials to be found in the town or country. This is mixed with a little soot, charcoal, gypsum, or other deodorizer, for the purpose of lining or packing the tub. A mould of the same shape as the tub, but six inches less than the internal diameter, is placed upon the four inches of absorbent material referred to, and the space between the mould and the tub is packed with the same kind of refuse. One boy can pack eighty tubs in an hour, and this is all the manipulation required, except in placing and removing the tubs at stated times. The absorbent material having been only moderately pressed down, the mould is withdrawn and there remains a cavity into which the dejections fall, the liquid parts of which are taken up by the absorbents, and retained by them so as to check fermentation."

Such dry methods are only applicable on a limited scale, the preparation, storage, and transport of dry earth or other material, and the removal of the excreta, involving in large towns enormous labour and expense, while it does not do away with the need of some water-carrying system for the removal of slop and waste water.

Sanitary Maxims.

In concluding our considerations of house-drainage, we may put the most important points to be attended to in brief space, in the following maxims selected from Mr. Pridgin Teale:—

1. It is the duty of every householder to ascertain for himself whether his own house be free or not from well-known dangers to health.

2. As a rule the soundness of the sanitary arrangements of a house is taken for granted and never questioned until drain-begotten illness has broken out. In other words we employ illness and death as our drain-detectives.

3. Whenever gas from sewers or the emanations from a leaking drain, a cesspool, or a fouled well, make their way into a house, the inmates are in imminent danger of an outbreak of typhoid fever, diphtheria, or other febrile ailments, classed together under the term zymotic, not to speak of minor illness and depressed vitality, the connection of which with sewer gas is now fully established. Sewer gas enters a house most rapidly at night, when outer doors and windows are shut, and is then perhaps most potent, in contaminating the meat, the milk, and the drinking water, and in poisoning the inmates.

4. The more perfect the public sewers of a town the greater the danger to every house, connected with such sewers, if the internal drain-pipes of the house be unsound, and not disconnected. In houses so misconnected *sewer air is laid on* as certainly for the detriment of health as coal-gas for illumination.

5. A house in which children and servants are often ailing with sore throat, headache or diarrhœa is probably wrong in its drainage.

6. Scamped drain work is one of the most dangerous of the sanitary flaws of new buildings; it is also one of the most common, and one of the most difficult to detect, and is rarely found out except by the illness it produces.

7. If you are about to buy or to rent a house, be it new or be it old, take care, before you complete your bargain, to ascertain the soundness of the sanitary arrangements with no less care and anxiety than you would exercise in testing the soundness of a horse before you purchase it.

8. If you are building a house, or can achieve it in an old one, let no drain be under any part of your house; disconnect all waste-pipes and overflow-pipes from the drains, and place the soil-pipe of the w.c. outside the house and ventilate it.

9. If there is a smell of drains in your house, or a damp place in a wall near which a waste-pipe or a soil-pipe runs, or a damp place in the cellar or kitchen floor, near a drain or a tank, let no time be lost in laying bare the pipes, or drains, until the cause can be detected.

10. If a rat appears through the floor of your kitchen or cellar, and a strong current of air blows from the rat-hole, when chimneys are acting and the windows and doors of the house are shut, feel sure that something is wrong with a drain.

11. If you are tenants and your landlord refuses to remedy the evil, do it at your own cost rather than allow your family to be ill.

12. Many a man who would be aghast at the idea of putting small quantities of arsenic into every sack of flour, and so by degrees killing himself and family, does not hesitate to allow sewer gas to poison the inmates of his house, even in the face of the strongest remonstrances of his medical adviser.

13. A landlord may reasonably look for interest on the money which he spends for the benefit of his tenant; but he is committing little short of manslaughter if, by refusing to rectify sanitary defects in his property, he saves his own pocket at the expense of the health and lives of his tenants.

14. If you be a landlord, don't intimidate your tenants, or threaten to give them notice to quit, if they complain of defective drainage, or sewer gas in the house.

To these we may add a final one:

15. Never use for domestic purposes water derived from a well situated in a street of town or village, or in proximity to dwellings. Be suspicious of water derived from any well in the immediate neighbourhood of a house or farm steading. However excellent it may appear, the risk of its being contaminated is very great.

SECTION V.—CLOTHING AND BATHING.

Clothing.

The Purpose of Clothing:
- *The Means by which the Temperature of the Body is normally maintained—* Regulation of Temperature by the Skin.

The Qualities of Suitable Clothing:
- *Clothing as a Conductor of Heat;*
- *The Absorption of Moisture by Clothing;*
- *The Porosity of Clothing;*
- *Practical conclusions regarding Material for Clothing;*
- *Inflammability of Clothing;*
- *Form and Shape of Clothing.*

Underclothing.
Night Garments.
Dress for Women and Children.
Dress for Men.
Covering for the Head—*Hats.*
Covering for the Feet—*Boots, Shoes and Stockings.*
Poisonous Dyes in Clothing.

Bathing.

The Uses of the Bath:
- *The Bath for Cleansing Purposes*—Soap.
- *Other Effects of the Bath.*

Varieties of Baths:
- *The Temperature of Various Baths;*
- *The Cold Bath*—The Wet Sponge—Wet Towel—Wet Sheet;
- *The Tepid, Warm, and Hot Bath;*
- *The Hot-air Bath*—The Turkish Bath;
- *The Vapour Bath*—The Russian Bath;
- *Sea and River Bathing*—Salt Baths;
- *Medicated Baths*—Alkaline, Sulphur, Pine, Mustard, and Mud Baths;
- *The Douche, Sitz and Needle Baths.*

The Uses of Baths in Disease.

CLOTHING.

The Purpose of Clothing is to aid in maintaining the temperature of the body at the proper, or normal level, that of 98°·4 Fahrenheit. It is not only that clothing is used as a protection against external cold, but it is employed also as a protection against external heat. It is evident that clothing must possess different qualities, according to the kind used, to enable it to fulfil these opposite conditions. Furthermore, we have said the purpose of clothing is *to aid* in maintaining the temperature of the body. Many people are too apt to consider that the heat of the body is maintained by clothing alone, and so they multiply wraps and coverings, regardless altogether of the material employed, and desirous only of interposing a thick enough layer between the surface of the skin and the cold atmosphere. When we say *to aid*, what is implied is that the body itself has the power of maintaining a normal degree of heat, which in some circumstances would be quite sufficient without any covering, but that when the variations of the external temperature are greater than the body can conveniently adapt itself to, some covering becomes a necessity. If clothing is then really to *aid*, regard must be had to the natural means by which the body endeavours to protect itself, so that the natural processes of the body may not be disregarded, abolished or subverted. By what means does the body maintain for itself a normal temperature? is naturally the first question. Heat is produced within the body, and heat is lost from the body. When the heat produced is equalled by the heat lost, the warmth of the body remains at the same level—there is a balance of heat production and heat loss. By the action of the nervous system, which it is unnecessary to consider in detail, the production of heat within the body may be increased or the loss of heat may be diminished to meet increased external cold, or the reverse may occur to meet increased external heat. The chief means of heat production in the body is chemical combination, the combination of carbon and hydrogen of the food with oxygen, contained partly in the food and also introduced by the air of respiration (p. 532). If none of the heat so produced were given off from the body, it has been calculated that in 24 hours the temperature of the body would be raised to the boiling point. Of the energy produced by this chemical combination $\frac{3}{4}$ths or thereby are given off from the body actually as heat, while $\frac{1}{4}$th is converted into mechanical work. The loss of heat from the body takes place from the skin, from the lungs, in heating the cold air taken in by respiration, and some is removed from the body by the excreta from the kidneys and bowels. Fully three-fourths (77·5 per cent) of the total heat lost from the body are given off by the skin, nearly 20 per cent (19·9 per cent) is given off with the expired air, and a small percentage (2·6 per cent) is lost with the excreta. It is with the skin chiefly that we have to calculate in considering how the body parts with its heat.

The skin loses heat in four ways (1) by radiation, (2) by convection, (3) by conduction, and (4) by evaporation. The meaning of radiation, conduction, and convection has been incidentally explained on p. 699. Radiation doubtless is affected by the clothing worn, rough clothing radiating more rapidly than smooth. A single illustration will suffice to indicate how heat is lost by radiation. Suppose we sit with our back towards a damp cold wall, but not touching the wall, radiation takes place from the body to the wall, and may take place so rapidly that we speedily experience a sensation of chilling, which is commonly attributed to draught, so that it is quite usual to hear some one say, "there is a very cold draught along that wall," while it is simply that the body is rapidly parting with its heat to the wall by radiation. We have all practical experience also of the meaning of convection and conduction. We know that when we sit in still air, its coldness or its heat is not so perceptible to us, as when the air is in movement. Air is a bad conductor of heat, and, while the air is still, the body parts with its heat slowly, for the heat is but slowly conducted through the motionless air; but if a current of cool air play upon a part of the body we are speedily aware of its influence. The particles of air come in contact with the body, become warm and pass off, to be succeeded by other particles, each getting its share of heat so that the body is being quickly robbed of its heat by the myriads of air particles carrying off each one its share. It is, however, by evaporation of sweat that the skin parts with heat most rapidly, and by a variation of the amount of evaporation that the loss is regulated to suit circumstances (see p. 309). Now these facts must be kept in view if one is to appreciate fully the best means by which clothing will fulfil the purpose it is expected to serve, since clothing can be considered to be suitable only so long as it properly reinforces the natural bodily means of regulating the temperature. This will be most easily understood by illustrating how clothing ought to be made to aid the maintenance of an equable bodily temperature (1) in winter or in a cold atmosphere, and (2) in summer or in a warm atmosphere. We may say that in winter there is an increased heat production because of an increased quantity of food consumed, and food of a more heat-giving character, and that in summer there is a lessened heat production because of less food consumed or food of a less energy-yielding kind. Setting this aside, however, we may consider only the variations in the loss of heat.

In **Winter**, or whenever it is exposed to a cold atmosphere, the body adjusts itself to the altered external temperature by a diminished flow of blood to the skin and, in consequence, a diminished loss by evaporation. It is merely a diminution of the loss, not an arrest of loss. Evaporation still goes on but to a diminished extent. Suitable clothing, then, will aid this process by interposing a barrier to the conducting away of heat from the body, or, to look at it from the other point of view, interposing a barrier to the conducting inwards to the body of the external cold, and this it must do *while not interfering with a healthy amount of evaporation from the surface of the body.* For suppose clothing is put on of a kind or in such quantity as to prevent the insensible perspiration (p. 309) duly passing off, what happens? The vapour becomes condensed and remains upon the surface of the body as moisture. The body becomes enveloped by a fine film of water. Now water is a better conductor of heat than air, and thus the condensed vapour is a direct aid to more rapid cooling of the body than is natural, exactly the reverse of what one desires under these circumstances. This is the explanation of the ready chilling of the body after copious perspiration. The sweat has formed more quickly than it can be removed as vapour; it condenses and forms a watery layer which facilitates the conduction of heat from the body. Many people heap clothes upon themselves and their children in cold weather, not only when going out of doors but also when indoors, and wonder why, in spite of all their wraps and precautions, they and their children feel and are so much subject to the cold. It is just because of their precautions that the tendency to cold manifests itself. Instead of aiding and abetting the healthy action of the skin, they interfere with and subvert it, creating the conditions for a too free perspiration, which, condensing as moisture on the skin, leads to a too rapid parting of heat from the body.

In **Summer**, or in a hot atmosphere, the warmth of the body would maintain its equilibrium mainly by a free but regular evaporation from the surface. Clothing should not interfere with this, and, therefore, ought to be of material which permits free passage to the vapour from the skin. But the clothing ought also to render service by being a non-conductor, so that the external heat may not be communicated to the body. It might be thought that in hot weather, the body should be clothed with material that is a good conductor of heat to enable the body to part more quickly with its heat. But if the external air be warmer than the body, the clothing that is a good conductor will rather conduct heat to the body than away from it. Even supposing the external air be slightly less than the temperature of the body and that, therefore, the clothing would conduct in the proper direction, conduction is not the method by which the body naturally parts with its heat to any great extent, and it is a method which does not act so uniformly, and regularly as that by evaporation. When conduction operates to any great extent, that is when the conduction is effected more rapidly than by air, it is apt to cool the body unequally by acting more on one part than on another; and chilling results. Moreover, clothing material that is good conducting material is as a rule less permeable to moisture, and would prevent the due evaporation of sweat, which would then condense upon the skin. Thus the loss of heat from the body would be accelerated in one way, and retarded in another, and in the chief way; while the risks of too rapid cooling of parts of the body would be incurred. In summer then the action of the skin would be aided by non-conducting material, which allowed free passage to the exhaled vapours, not only by the nature of the substance of which it was made, but also by the thinness and openness of texture of the cloth.

The Qualities of Suitable Clothing we are now prepared to understand more fully. (1) It should be made of material which is a bad conductor of heat. (2) The material should readily absorb moisture, so that the vapour of perspiration may be allowed to pass off from the body, and may not be caused to accumulate between the clothing and the skin, leading to condensation. (3) It should be more or less porous in texture, by which is meant that the cloth should be able to contain air in its meshes or fine channels. This will effect two objects. Air is a bad conductor, and a cloth which is so woven that it may contain a considerable quantity of air will be a better non-conductor than one of the same thickness so closely woven as to retain little air. The more porous material will, secondly, allow of movement of air in its meshes, of ventilation that is to say, and will be better adapted to permit due exhalation from the skin. These qualities of clothing we shall now consider in some detail, in order to learn what kinds of material possess them to greatest extent.

Clothing as a Conductor of Heat.—The following list shows the relative position which the different materials, used for clothing, occupy, the best conductors being placed at the head.

Flax and linen,
Cotton and calico,
Silk,
Wool,
Eider-down,
Fur.

The fur of the hare, according to Rumford, conducts least of all substances used for clothing, and next to it come down and wool. According to the same authority, if the conducting power of linen be represented by 100 that of wool is from 50 to 70. Putting this in a popular way, of two coverings of linen and of wool both of the same thickness and texture, the woollen one would be nearly twice as warm as the linen one. Though it is put in this way it must be remembered that there is no actual warmth in either, the meaning is simply that the linen conducts the heat away with nearly twice the rapidity of the wool; that the wool, in other words, retains the heat and thus maintains the warmth of the body. In the same way the woollen material would retard the excess of heat from the outside. Thus ice wrapped up in wool will melt more slowly than if exposed to the warm external air, for the wool keeps out the heat. Between linen and cotton cloth—calico—there is no great difference. Thus, in an experiment, the same degree of heat was imparted to linen and calico, and it was found that the former cooled down in $10\frac{1}{2}$ minutes and the latter in $11\frac{1}{2}$. Linen is, however, actually the best conductor of all materials used for clothing, and, therefore, the least desirable of material for that purpose. This conduction of heat is not affected by colour; it is determined by the material of which the clothing is made. Moreover it is to be distinguished from the absorption and emission of heat, which colour affects to a considerable extent. What is meant by the absorption and emission of heat will be understood by comparing heat to light. A substance which permits light to pass is called transparent, it does not absorb the light; a substance which absorbs the light—does not permit it to pass—is called opaque. Now we may say some substances are transparent to heat, that is, they allow the heat to pass through without absorbing it, so that in consequence they do not become warm. This is true of air, the heat rays from the sun or from a fire pass through it without warming it. Other substances do not permit the heat to pass through, they are opaque to it, so to speak, they absorb it. Substances which absorb heat also give out the heat or emit it, later. Thus glass is transparent to light, but it is not so to heat. It absorbs the heat rays. If one is sitting in front of a fire and, feeling the heat too great, interposes a screen of glass, at once the intense heat is diminished, but the light is unaffected, the fire is plainly seen through the glass screen. The screen has been cold before it was placed in front of the fire, but it soon grows warm; that is to say, it intercepts or absorbs the heat rays, and therefore becomes warm, and by and by emits the heat. It is useful under such circumstances, for it prevents the heat being poured in a too intense stream on one place; but the heat is not lost. It is given out later in a more gradual and pleasant fashion, warming the room more regularly and comfortably. This illustrates what is meant by absorption and emission of heat, and how it differs from conduction, for glass is not a good conductor. In the same way clothing may absorb heat and emit heat apart altogether from conducting power. While colour does not influence the conduction of heat to any extent, it seems to have a marked influence on the absorption of heat. This is of importance as regards the gain of heat to the body from without. Thus suppose two garments of the same material, thickness &c., but one black and the other white, and suppose the sun's rays to be playing equally upon both, the black garment will absorb much more heat than the white one because of its colour alone, and the individual wearing the black one will feel the heat much more intensely than the individual wearing the white garment. Thus experiments were made to determine the amount of heat that would be absorbed in the same time by material made of different substances, cotton, linen, flannel, and silk, but all white, and comparatively little difference was found between them. When, however, shirtings *all made of the same material*, were used, but *all of different colours*, the amount of heat absorbed was found to vary very markedly with the colour.

Thus when white	shirting	absorbed heat	to raise it to	100°	F.
pale-straw	shirting	,,	,,	102°	,,
dark-yellow	,,	,,	,,	140°	,,
light-green	,,	,,	,,	155°	,,
dark-green	,,	,,	,,	168°	,,
turkey-red	,,	,,	,,	165°	,,
light-blue	,,	,,	,,	198°	,,
black	,,	,,	,,	208°	,,

Scientific facts are, therefore, in agreement with the facts of experience in testifying that light-coloured garments are coolest for summer wear, and dark-coloured warmest for winter wear, not because they conduct the heat differently, but because the light garment absorbs least of the sun's rays and black absorbs most. So in summer we use the garment which, because of its colour, will refuse to absorb much heat, and in winter we adopt the colour which will absorb most and aid in keeping up our bodily warmth.

The Absorption of Moisture by Clothing.—The power of absorbing moisture is a most important quality of clothing. It is according to the degree to which clothing absorbs moisture that it does not interfere with the natural exhalation from the skin. If the material covering the body readily takes up vapour, then the perspiration passes into the clothing and is given off on the outside; but if the absorptive power of the clothing is little, the body is kept enveloped in an atmosphere saturated with vapour, and with the slightest exertion becomes bedewed with moisture—a most uncomfortable position to be in, and one which is attended by considerable risk of catching cold, as we all know. This quality of absorbing moisture is called the **hygroscopic property** of clothing material. This property has received careful investigation at the hands of Pettenkofer, who took pieces of different materials, all of the same size and weight, and having carefully dried them at 212°, weighed them, and thereafter exposed them to the atmosphere of different places, more or less damp, for varying periods. He then weighed them to discover how much moisture had been absorbed. The following are some of his results:—

After 12 hours	in a cellar	there had been absorbed by linen	77 parts of water, by flannel	157 parts.
,, ,,	,, room	,, ,, ,,	41 ,, ,,	75 ,,
,, ,,	,, laboratory	,, ,, ,,	69 ,, ,,	105 ,,
,, 10 minutes	,, room	,, ,, ,,	73 ,, ,,	113 ,,

Results of other observations are shown in the following table. Various materials were taken of the same weight, dried in a hot chamber for 24 hours, and then exposed (1) for 48 hours in a cold uninhabited room, and then weighed. The same materials after drying were exposed (2) for 72 hours in a damp cellar, and thereafter weighed. The results were as follows:—

	Weight at the End of the 1st Experiment.	Weight at the End of the 2nd Experiment.
Sheep's wool,........	1084	1163
Fur, ...	1072	1125
Eider-down, ...	1067	1112
Silk, ...	1057	1107
Linen, ...	1046	1102
Cotton, ...	1043	1089

The weight of each substance before exposure was 1000.

With flannel, according to Pettenkofer the maximum power of absorbing water is represented by 174 and the minimum 111, while with linen the maximum was 75 and the minimum 41. He took two pieces of flannel and linen of equal weight, put them into water, and then wrung them out till no more water could be squeezed out. He found that for every 1000 parts of weight of the flannel 913 parts of water were retained, and for every 1000 parts of linen only 740 of water were retained. He also proceeded to determine the rate at which wool and linen gave off water with which they had been wetted, and observed that wool dried more regularly than linen, the water being given off rapidly from the linen at first and then more slowly, but from wool with less rapidity to begin with but more steadily, so that in the end more water was given off from the wool than from the linen in the same time.

Now what is the bearing of these facts? It will be observed that the order of absorptive power for moisture is just the order of non-conducting power for heat, so that the clothing material which conducts heat least is the material which absorbs moisture most. Such clothing, when covering the body, will conduct the heat from the body with least rapidity but will interfere least with the natural evaporation of sweat. These, as we have seen, are exactly the conditions one desires in suitable clothing. It is the kind of covering for the body which will interfere least with the natural means by which the body regulates its temperature. Suppose the body to be engaged in active exercise, by which a large amount of perspiration is induced: if linen be next the skin, it will speedily become saturated with moisture, and the uncomfortable feeling of soaking garments will soon arise. If woollen clothing be worn, the wool will absorb much more moisture before it becomes saturated, and the active exercise will be engaged in for a considerably longer period before the discomfort is experienced. Then suppose the person sits down to rest, rapid evaporation will immediately take place from the linen, and the heat of the body will be quickly reduced, a feeling of chilliness being the result, while the evaporation from the woollen material will be more gradual, so that a natural process of cooling will result with much less chance of chilliness. "In other words, a person after violent exertion may sit down on a cool bank, if dressed in a flannel shirt, with less danger than if his dress were linen."

There is another point of view from which this quality of clothing must be considered. Suppose the moisture does not come from the body but is external, suppose, that is, that one is in a damp atmosphere, then the woollen clothing will absorb the moisture from without more rapidly than the linen; and this may seem to be to the disadvantage of the former. But then the woollen clothing will be able to take up more water before it is saturated than the linen, which will become speedily soaked, so that the disadvantage is, in this way, counterbalanced. One will, therefore, be able to bear exposure to the damp atmosphere longer without discomfort when clothed with woollen material.

Clothing can be made impermeable to moisture by various means, and the body may thus be protected from external damp by an outer covering of impermeable substance. This will appear all the more desirable when we consider the greatly increased weight woollen garments must have when soaked with moisture. If 1000 parts of flannel can take up 157 parts of water, a woollen garment which, when dry, weighs 10 pounds may take up enough moisture to weigh 11½ pounds. The added weight which the body will thus require to carry, if one wears a long heavy woollen garment, such as an "ulster," is not too insignificant to be taken into account. Impermeability to moisture is conferred on cloth by various methods. Mackintosh's patent, by which what is called Mackintosh is produced, applies a varnish made of a solution of caoutchouc in rectified petroleum or naphtha between two layers of cloth. A similar varnish may be laid on one side only of the cloth. A solution of caoutchouc in linseed-oil is also employed, and linseed-oil boiled with sugar of lead. A solution of soap may be also used worked into the cloth and then acted on by a solution of alum. This prevents the passage of water into the pores of the cloth; or if the cloth be impregnated with a solution of isinglass or glue, and then acted on by a clear infusion of galls, a similar effect is produced. For rougher material hot tar is employed. Of all these methods those of Mackintosh are the most used, the solution being applied either between two layers of cloth or on the outside of the cloth. The cloth prepared by the first method is most sought, because of its appearance, but that prepared by the second is in some respects the better, because, being quite on the outside, it prevents any moisture being taken up from without, while, in the former case, the outer layer of cloth becomes soaked and consequently heavier.

Such impermeable material, however, illustrates the disadvantages of wearing clothing not capable of absorbing moisture, if it be worn for any time. The natural evaporation from the body is interfered with, and a feeling of oppression is produced, while perspiration collects on the skin. Such material should, therefore, be worn for as brief a period as is really necessary, and should be removed as soon as the necessity is passed.

The Porosity of Clothing depends to some extent upon the material of which it is made, but chiefly on the manner in which the cloth has been woven, its closeness of texture being the chief circumstance modifying it. By porosity is meant the extent to which air may penetrate the cloth, because of spaces, channels, pores &c. The porosity of various materials has been determined by finding the amount of air that could be forced through a piece of the cloth with a certain pressure in a given time.

Through	flannel	10·41	measures of air passed.
,,	lambskin	6·07	,, ,, ,,
,,	linen	6·03	,, ,, ,,
,,	wash-leather	5·37	,, ,, ,,
,,	silk fabric	4·14	,, ,, ,,
,,	glove-leather	·15	,, ,, ,,

Pettenkofer obtained results showing that in the same time in which flannel allowed 100 measures of air to pass

Linen and buckskin	allowed	only	58
Chamois	,,	,,	51
Silk	,,	,,	40
Kid	,,	,,	1

In short the clothing that experience admits to be the warmest is that which conducts heat least, absorbs water most easily and allows the air the freest passage. That clothing which permits air to pass most readily should be the warmest may seem at first sight to be strange and unexpected. When we consider, however, that the meshes and canals of porous clothing are filled with air, and that air is a non-conductor of heat, the explanation is forthcoming. To speak of a covering of air might seem an absurdity, but in plain fact when one wears a porous garment one is kept warm, not by the cloth covering alone, but also by the layers of air which occupy the interstices of the cloth. Now the porous garment will readily admit of the removal of the products of perspiration, and will not interfere with the function of the skin.

The porosity of clothing has a marked relationship to the non-conducting power of cloth. The conducting power of a material does not depend upon porosity but upon the nature of the material itself. Nevertheless the looseness or closeness of the texture of the cloth will modify the conducting power, just because with a loose cloth the non-conducting power of air is brought also into play. Thus Krieger employed tin cylinders which he filled with hot water, and he noted the rate at which the cylinders cooled when they were enveloped with different substances. In one observation he covered the cylinders with loose common wadding, and found the tin parted with its heat slowly: then he compressed the wadding, and the temperature fell much more rapidly. In short by compressing the wool he diminished the air spaces in the wool, and expelled much of the air, and thus lost the benefit of the air covering. For similar reasons a tightly-fitting covering permits of a more rapid loss of heat than a loosely-fitting one. The tightly-fitting one, by its close application to the body it covers, permits the full action of any conducting power the garment may possess; while the loosely-fitting one has its conducting power for heat largely set aside because a layer of air is interposed between the garment and the body. In the sense already explained a person who wears loosely-fitting clothing may be said to wear next the skin a garment of air, and retains much warmth of body on that account. This explains also how it comes about that two thin garments are warmer than one garment equal in thickness to the two put together. The two garments have between them a layer of air and thus actually present a greater thickness of non-conducting material, because of the film of air, than the single thick garment. For this reason it is better, instead of having light flannels for summer wear and heavy flannels for winter wear, to use the same thinness of flannel summer and winter, but to put on more in winter than in summer, to wear two in winter and one in summer.

Practical Conclusions regarding Material for Clothing.—The facts that have been considered show that under all circumstances woollen material is the most suitable for clothing. It conducts heat least, it absorbs most moisture, and it permits most readily the passage of air. It is well fitted to aid the skin in maintaining a normal temperature, without interfering with the proper functions of the skin as an organ of excretion (see p. 308). For summer or for winter it is alike valuable, modifications in the quantity of clothing worn, in the number of garments, in the closeness or openness of the texture, being alone necessary to meet the very different conditions of summer's heat and winter's frost. While valuable in every climate, in none is it more valuable than in that of the British Islands, where dampness and rawness of atmosphere are prevailing characteristics, because, by its ability to absorb a large amount of moisture before being saturated, and afterwards to permit the moisture to evaporate gradually, it prevents sudden and great diminution of the bodily temperature, which would certainly be the result of cotton or linen clothing. For precisely the same reasons is it pre-eminently valuable in hot climates, where the intense heat of the day gives place, immediately on sundown, to a rapid cooling; when persons are at one time broiling in the sun and soon afterwards shivering with cold. It is these sudden changes of temperature that clothing should be specially fitted to modify, and no article of clothing material is so suitable for such a purpose as wool. Again it is the best protection to the person who, for one reason or another, has little active exercise to assist in the production of heat within the body; and it is the only really safe article of clothing for any engaged in very active or even violent exercise followed by periods of inaction, as in the games of cricket, football, tennis &c. At the period of violent exercise the person wearing woollen garments will certainly feel warmer than another clothed in cotton or linen, but the woollen material permits the normal activity of the skin in its effort to maintain the balance, while the cotton or linen upsets it by greatly increasing the conduction of the heat from the body. The result is seen as soon as a pause in the exertion occurs, when the person clothed in cotton becomes aware that his clothing is soaked with perspiration and fears he will begin to feel chilly immediately, while the other individual is quietly, naturally and comfortably cooling down. Woollen clothing should then always be worn next the skin. The garment should be of only moderate thickness, not too close in texture, and should not be tight fitting. Whenever it becomes necessary to increase the amount of clothing it should be preferably by the addition of another garment to the first, not by substituting a thicker one for the first.

In cold weather the garment should be black or of a dark colour, in hot countries or at hot seasons it should be white or light-gray.

Knitted woollen underclothing is the best, but it should be neither too fine nor too close. It used to be objected to woollen underclothing that it was too heavy for summer weather. But woollen garments can be obtained of any required thickness, and a woollen garment of the same weight as a linen one is much warmer. An objection in which there is more of truth is that woollen material next the skin is irritating. It undoubtedly stimulates the skin, and if rough reddens it markedly. Flannel especially has such a disadvantage. But of recent years so much attention has been given to the manufacture of the wool for such purposes and to the knitting of undergarments, that the objection has now much less force. Woollen underclothing can be obtained as soft and fine and non-irritating almost as any linen garment could be. There are, however, a few people, not many, who find wool next the skin really irritating, no matter in what form it is. They should not, therefore, abandon woollen underclothing, but may protect the skin by interposing between it and the wool a fine large-meshed gauze garment. In such cases silk might be worn next the skin.

One objection, however, to woollen underclothing of some force is that it shows dirt much less quickly than other materials, and that, in consequence, it is often worn unchanged for far too long a period. This, however, is scarcely a disadvantage pertaining to the material itself, but properly is an evil to be laid to the door of the wearer.

Inflammability of Clothing.—It is worthy of notice that woollen material, which we have found so thoroughly to answer all the requirements of healthy clothing, is also one of the substances least open to objection on the ground of risk of catching fire. It will burn slowly, will smoulder, but will not easily burst into flame. Cotton and linen, on the other hand, will readily burst into flame and be rapidly consumed. A linen or cotton dress, pinafore, or apron, taking fire will speedily flare up, the flame spreading from one part to another, till the whole is in a blaze, and the flame is not easily altogether extinguished. When such a garment catches fire, serious and fatal injury may be occasioned before it is put out. If a woollen garment is similarly exposed, the fire does not quickly extend, is more limited to the one place, and may thus be arrested before harm is done. The more dense the fabric the more slowly does the combustion proceed. Leather has a similar advantage. Silk is more inflammable than wool, but much less so than either cotton or linen. Whenever the occupation exposes the person to risks of fire, woollen material should invariably be selected. Of all articles of dress, muslin, from its openness of texture, is most dangerous. The plan of extinguishing fire on clothing by enveloping the person in a blanket, rug, shawl &c. is based upon the small inflammability of the wool of which the blanket &c. is formed.

It is possible, however, to render linen, muslin and other cotton goods non-inflammable by impregnating them with some material, which resists fire. Of such substances the most useful is tungstate of soda, and molybdate of soda. The former is that chiefly used. These substances are dissolved out in washing, however, and the material requires re-treatment with the solution after each washing. The tungstate of soda permits the material to be ironed without change being produced; it does not injure the material either in texture or appearance, nor does it affect the colour. Other substances, used for the same purpose, either do not stand ironing, or change the colour of the garment, or give the material an unfinished appearance. Sulphate of ammonia, for example, which is cheap, a ten-per-cent solution of which renders a garment, dipped into it and then dried, non-inflammable, affects some colours, especially madder-purple. Phosphate of ammonia, also used, gives a "chalky" finish. Material made of asbestos absolutely resists fire. It may be heated to redness without being consumed. The other materials chemically treated, while they do not burst into flame, will yet become charred. "Fire-proof starch," recommended for muslins, &c. is starch prepared with tungstate of soda; and when used as ordinary starch it renders the material non-inflammable.

The Shape and Form of Clothing should have regard to these conditions: (1) The clothing should not be tight-fitting, for reasons explained in the paragraphs relating to porosity of clothing; (2) It should not be redundant, necessitating the stowing away of unnecessary material; (3) It should nowhere exert undue constriction on any part. Increased tightness anywhere inevitably interferes to a greater or less extent with the normal circulation of the blood, leading to deficiency of supply of blood to the parts beyond the line of constriction and consequent coldness, or more certainly to slowing of the blood current returning by veins to the heart. A good illustration of this is the aggravation of varicose veins by constriction, as by the use of tight garters.

Underclothing should always and everywhere be of wool, for reasons already sufficiently explained in the preceding paragraphs. If it prove, as it sometimes, but not often, does, too irritating to the skin, a fine open-meshed garment of silk or lawn may be interposed between the woollen garment and the skin.

Night Garments should be of wool for the young, for the old and feeble, and for delicate persons, those liable to cold, lung affections, and for the rheumatic. In very cold climates they may be necessary for all, and they should certainly be worn by any, who are frequently required to get out of bed during the night. For persons in full health and vigour, however, under ordinary circumstances, a cotton or linen night-dress is to be preferred. It is far cleanlier to begin with. In bed, moreover, circumstances do not demand warm clothing. There is no exercise to induce perspiration. There are no sudden changes of temperature to be guarded against. There is no conduction away of heat to be feared. The bed-clothes should offer sufficient protection against that; and under such circumstances cleanliness is the main consideration. Moreover the stimulating effects of the wool in direct contact with the skin are not desired in bed, as they would tend to produce too great a feeling of warmth, and the skin to some extent should be allowed to share in the rest permitted to the other parts of the body.

"A man might as well sleep in his boots as seek repose in a night-cap," says Mr. Treeves, the London surgeon; and "for the majority of individuals the night-cap is no more an essential to health than it is a contribution to personal beauty." If that is true as regards men it is still more true when applied to women, whose copious hair affords all necessary protection.

Dress for Women and Children has already been sufficiently considered in pages 472, 444, and 452. It is only necessary to say that the reasons given for woollen underclothing apply to them with full force, in some respects with even greater force than to men, for women have, as a rule, less active lives than men, and children are much less able to stand any exposure to cold.

Dress for Men should fulfil the conditions already stated at length. Trousers should be suspended by braces from the shoulder, not by belts or straps, which exert undue pressure on the abdominal organs, and thus may increase any tendency to rupture. Still more are such appliances hurtful, or likely to be so, when used to enable increased exertion to be put forth, as in running, leaping &c.

Covering for the Head.—The hair is the natural covering for the head. It is a bad conductor of heat, it allows free evaporation of moisture, it is porous, and it is light. Thus it exhibits all the conditions of suitable clothing, and in its natural state is thus well fitted to afford protection to the head. In its natural state, we say, but it is seldom permitted to be in its natural state, for, when well oiled and well brushed down, it is both a better conductor and less porous than it ought to be. If oil or pomade be necessary for keeping a tidy arrangement of the hair, only so much should be used as is really necessary for that purpose. That the hair is in ordinary circumstances quite an efficient protection is proved by the large number of persons, even in the uncertain climate of Britain, who habitually use no additional covering. Some covering is, however, used by most people in civilized countries, partly for tidiness sake, and partly as an extra protection against cold, wet, or heat, as well as because custom demands it. Such additional protection should fulfil the same conditions applicable to coverings for any other part of the body. It ought not to conduct heat, it ought to allow evaporation of the perspiration from the scalp, it should not be heavy, nor should it constrict any part of the head. The ordinary tall hat worn by men violates all these conditions. It very commonly catches at front and behind; it is very likely to be heavy; and for want of ventilation it becomes a hot-air box confining the vapours from the scalp. Its faults are most conspicuous in summer, particularly when it is black in colour. It is, thus, prone to produce a feeling of weight and oppression and perhaps headache. Felt is an appropriate material for hats; and there ought to be no difficulty in making them properly fitting and light, but ventilation is not so easily effected, since that implies an opening for the entrance of fresh air as well as an outlet for the escape of exhaled vapour. Woollen or flannel caps need no such provision since they are made of porous material, provided that material is not of too close texture. Straw hats fulfil all the required conditions.

For protection against heat, the heat of the sun in summer, for example, the head covering should be of white material, and should be so shaped as to shield the back of the head as well as the top and the face. The ordinary broad-brimmed straw hat is the most useful for such a purpose. In excessively hot climates the back of the neck should also be protected by it. It should be so made as to permit the free passage of air through it. For India the pith or bamboo-wicker helmets, covered with cotton, are said to be the most suitable head covering, being of great advantage in diminishing the risk of sunstroke. In excessively cold climates, again, fur caps are the most suitable.

Covering for the Feet.—It ought not to be necessary to consider what is the appropriate covering for various parts of the body in detail, since the same conditions, already laid down on p. 729 and the preceding pages apply equally strongly to all parts of the body. We need only refer to one or two points in the clothing of the feet which transgress these conditions. If the general surface of the body should be clothed in non-conducting material, much more ought the feet which come into more or less direct contact with the ground, and can, therefore, be more readily robbed of heat than other parts of the body. Cotton socks or stockings ought, therefore, never to be worn, but always woollen, the thickness being dependent upon the season. It should also be noted that if socks or stockings are knitted of too hard wool and too closely, they are less porous, contain less air in their meshes, will be more easily soaked and matted with moisture, and will afford less protection against loss of heat in cold and wet weather. Stockings or socks with a compartment for each toe, as gloves have for each finger, are warmer, more cleanly, and more likely to be better fitting than the ordinary kind. Then tight-fitting stockings are less warm and comfortable than the more loosely fitting, provided the latter do not exhibit the fault of the other extreme of too much material, requiring to be crumpled up in the boot. What has been said should also show how great an evil garters are. If they are to be useful at all they must be tight, and if tight they compress the veins, preventing the due return of blood from the foot and leg. The sluggish circulation thus induced is a frequent cause of cold feet, and of pain and weariness in the limbs of which women so commonly complain. It is besides a serious cause of enlarged (varicose) veins. Stockings should, therefore, always be kept up by "suspenders."

Boots are commonly far too stiff and unyielding to permit the movement of the foot proper to walking, unless in the case of women's boots when they often are far too thin to yield protection against cold or wet or even the mechanical discomfort of a gravelled walk. The spring of the step is taken from the ball of the toes, and here the boot should yield easily, so that a person ought to be able to stand on tiptoes almost as readily with boots as without them, the boot bending as the foot does. Unyielding boots not only interfere with this movement, but indeed with the free play of the whole foot, so that all the mechanical advantage and elasticity, derived from the foot being formed of numerous bones, jointed so as to form an arch across the foot as well as from heel to toes, is lost; and the foot moves in its inclosing box as a solid mass and not as a yielding elastic structure. The result of the constant wearing of such boots is that the foot actually loses its natural elasticity; the muscles of the foot not being allowed free exercise do not attain to full development and are permanently weak, and walking is a labour instead of a pleasure. Obviously the natural movement of the foot will not be permitted in boots which are made without regard to the shape of the foot. The outline of the foot should, therefore, determine the shape of the boot. In this respect many boots err in the narrowing towards the toes, which crushes the toes together, causing one to ride over the other. The heel, which ought to be nearly as large as the ball of the heel itself, is usually too small, too high, and placed too far forward. The high heel throws the body into the position approaching that of the person, walking on his toes, and disturbs the natural balance of the body, so that to maintain the erect posture more muscular effort is required, while its forward position practically destroys the value of the arch of the foot from before backwards. The weight of the body being thus thrown forward crushes the toes forwards against the points of the boots, and tends to bend the toes, and to press unduly upon the nails, deforming them and occasioning ingrowing toe-nails. The small heel affords far too narrow a basis of support, so that the body is unstable. For a man the heel should not be more than ¾ths inch high and should be placed well back. Boots, if properly fitting and of pliable material, do not press unequally upon any part, and thus avoid the causes of the production of corns and bunions, the result of undue and unequal pressure. At the same time boots ought not to be so large as to permit the feet to move about loosely within them. The friction so produced would quickly raise blisters and cause thickenings of the skin.

How often are all the evils that have been indicated exemplified to the full in the boots of children! They are bought large to suit their growth, and heavy that they may the less easily be knocked to pieces, and they are made to pass up the leg to give additional support to the ankles!!! So the child's feet are tied up in a box, and her toes are twisted and squeezed into a shape nature would never have produced, and muscle is wasted for the sake of economy in shoe leather, and the surest of all methods is adopted to produce weak ankles instead of avoiding them. The moderate and natural use of a part is the best means of strengthening it. It is with regular, but not excessive, exercise that muscles grow strong and well-formed. When such exercise is prevented by artificial bands and strappings, the surest means of inducing weakness are being adopted. Special care ought, therefore, to be taken with the covering for children's feet, since the growth will be powerfully affected by the nature of that covering. Probably shoes would be more suited than boots, since they allow a freer action of the ankle joint, and they also allow, better than boots, of the escape of moisture from the feet. If, from the beginning, the child's feet are allowed free play in well-fitting shoes, pliable, and not so heavy as to tire out the young muscles with lifting them, there need be little fear of badly-shaped feet or weak ankles. But if under the name of strengthening weak joints, the natural growth and exercise of the muscles and ligaments of the foot and ankle are interfered with, weakness will certainly result, and the necessity of external support will become more pronounced as the child grows. The weakness, in short, which the mother points to as the proof of the need of the external support, is the result of the support.

Poisonous Dyes in Clothing.—There are on record numerous instances in which symptoms of poisoning have been traced to the clothing worn, dependent upon the stuff used to dye the material. The poison to be feared is arsenic, some of the preparations of which may be deliberately used for colouring purposes, such as the arsenite of copper, which is green; while some forms of arsenic are found as impurities in other colours employed. Thus magenta (rosanaline or fuchsine) which when pure is harmless, is sometimes contaminated with arsenic, and most of the cases of poisoning from clothing have been owing to this dye in the cloth. In the pigments known as cochineal red and coralline it has also been found. The effects so produced may be twofold. Arsenical vapour or dust may be given off from the fabric and be inhaled, leading to symptoms of chronic poisoning, perhaps for a long time not recognized as such. The usual symptoms are headache, sickness, loss of appetite, languor, feverishness &c. In the second place the clothing may directly irritate the skin, leading to redness, swelling and inflammation of the skin, producing perhaps an eruption. In all kinds of printed and woven materials, used for clothing, has arsenic been found, in flannel vests and shirts, in socks and stockings, in hats and gloves, in artificial leaves and flowers, as well as in table-cloths, carpets, wall-papers &c. It may be well to observe also that clothing is capable of absorbing not only moisture but also odours and emanations of various kinds. The extent to which such absorption occurs depends to some extent upon the colour of the cloth, black absorbing most, then the other colours in the following order—

Blue - Red - Green - Yellow - White;

the last absorbing least. That the contagion of infectious disease clings tenaciously to clothing and may be easily transported from place to place by it is well known, and is a means of spreading such diseases not too carefully guarded against. The relation between the absorption of odours and colour would seem to indicate that nurses in attendance upon any infectious disease should be clad in light-coloured washing dresses and not in dark garments.

BATHING.

The Uses of Bathing.—The primary use of the bath is for the promotion of cleanliness. Both from within and from without do materials accumulate upon the skin which, if allowed to remain, interfere with the proper and healthy discharge of its business in the bodily economy. On p. 387 and following pages the nature of that business has been pointed out. By means of the sweat-glands, and the sebaceous glands connected with the hairs, material is constantly being removed from the blood for expulsion from the body. But these glands may become easily blocked at their outlet, the excretion escaping with difficulty. From the surface of the skin dried scales of the scarf-skin are being separated in the form of fine dust. These, mingling with the moisture from the sweat-glands and the oily material from the hair-glands, form a material, readily remaining upon the skin, covering over the minute openings of the glands, and so interfering with the function of the skin, diminishing its activity as a purifier of the blood, and possibly leading to disease. Then from without dust &c. settles upon the skin increasing its defilement. The primary use of bathing is to cleanse the skin from such impurities. For these purposes the regular use of cold or tepid water with soap is effective, but it is not completely so. It removes the surface material but has less effect on the deeper parts of the glands, which are more effectually cleansed by the common practice of the weekly warm bath. By the latter means what may be called a flushing of the tubes of the glands is produced. The warmth brings a large supply of blood to the skin, and stimulates the glands to increased activity. The increased quantity of sweat thus produced causes, so to speak, a flow down the tubes and washes out any material which may have collected in their interior, which the daily wash may not have been sufficient to remove. This is even more thoroughly effected by the hot-air bath, one of the features of the Turkish bath. This is, indeed, one of the most valuable effects of the hot-air bath, the very copious perspiration produced by the action of the hot air on the skin causing a very thorough clearing out of the gland-tubes or "pores of the skin," as they are commonly called. So that so far as cleansing purposes are concerned, the daily ablutions with soap and water, the weekly warm bath, and an occasional hot-air bath would be a most excellent arrangement.

All water for ordinary bathing purposes ought to be soft. The softer it is, the greater is its cleansing property, because the more readily does it soften and dissolve impurities. Besides, hard waters are liable to irritate the skin, and many persons are very liable to such irritation; and hard waters are very uneconomical in soap. The methods of softening hard waters have been explained on p. 639. Rain-water properly purified would be extremely useful for cleansing purposes, where the domestic supply was of hard water. The mere act of boiling water softens it (p. 639), and thus hard water used for hot baths will be less disadvantageous than if the water were used cold. But a suggestion has been made by which, by simple and not expensive means, a supply of distilled water for washing purposes might readily be obtained in every house provided with a hot-water boiler. Such boilers are all provided with a pipe by which the steam blows off. This usually discharges into the open air. If this pipe were made in a spiral form, carried through a small tank of cold water and then made to open into a cistern, the steam would be condensed and caught as distilled water in the cistern, from which it could be drawn off as required.

Soap is prepared by boiling fat, derived from the ox or sheep and vegetable substances, with caustic-soda solution, a hard soap being thus produced; soft soap is the product of boiling fat with caustic potash. The oil from the olive mixed with other vegetable oils is used for Castile soap, the white variety of which is one of the most excellent and soothing quality. Palm-oil, cocoa-nut oil, and other vegetable oils are used for the same purpose. Curd soap, when pure, is made from tallow and soda only, and is of good quality. Curd soap and palm-oil soap are the usual basis of most toilet soaps, to which a proportion of glycerine may be added, in the glycerine soaps, and to which also colouring matters and various perfumes are added. Some colouring agents are injurious; red and magenta colours should be avoided, the red colour being sometimes derived from a mercury or lead preparation, and the magenta colouring matter being liable to contamination with arsenic. The safest soaps to use for the skin are the pure white curd or Castile soaps, and the transparent soaps of makers of repute. The transparent soaps are less likely to be adulterated than others, since adulteration would interfere with their clearness. An excess of soap will unduly soften the skin, owing to the action of the soda, and therefore the smallest quantity that is suitable should be employed, and very thoroughly washed off afterwards with water. None should be left for removal by the towel.

The use of the hands is to be preferred to sponges, flannel cloths &c., for the fingers can more effectually insinuate themselves into the folds of the skin and the due amount of pressure can be better regulated. The friction of the hand is also pleasantly stimulating to the skin.

The bath, however, serves other purposes than those of cleansing, though none more valuable. The hot bath relaxes the blood-vessels of the surface and causes a freer circulation in the skin. If more blood flows to the skin there is, of necessity, less in deeper organs, which are consequently relieved, and a soothing and calming effect is thus produced. None of the organs of the body experiences such effects more markedly than the nervous system, and the effect of the hot bath in inducing sleep is thus explained. The cold bath, on the other hand, drives the blood to the deeper parts and promotes their activity, though, if the cold be not too prolonged, reaction sets in when it is over, blood flows more freely to the skin, and a general stimulating effect is produced. For such reasons the evening, before retiring to rest, is the most suitable time for the warm bath, and the morning after rising for the cold bath, the former conducing to rest, the latter to activity. Various methods are employed for concentrating the action of one or other on special parts or organs of the body, such as by the hip or sitz bath, douch and needle baths and so on, which will be considered in a little more detail. Thus baths are made use of not only for the ordinary purposes of health, but also for the treatment of disordered states of the body, their value for which has been recognized only in recent years.

Too frequent bathing of the skin, whether of one part or of the whole surface is not commended, specially if each time soap is employed. The oily matter produced by the sebaceous glands is designed to oil the skin and keep it soft and pliable. If it is too frequently removed, the skin becomes too dry and is prone to crack or chap. Other consequences may ensue from the skin being irritated by the excessive stimulation, such as the production of eruptions and so on. The skin of some is much more susceptible to such influences than that of others. For example some can scarcely use soap to the face, because of the irritation it induces. In such cases the addition to the water used of a few drops of weak ammonia, spirits of hartshorn, or a tea-spoonful of sal volatile, will effect the removal of oily matter from the surface without irritation.

Varieties of Baths.—The temperature of the various kinds of baths is given in the following table:

Cold Bath	50°	to	70°	Fahrenheit.
Tepid ,,	85°	,,	95°	,,
Warm ,,	96°	,,	104°	,,
Vapour ,,	96°	,,	110°	,,
Hot ,,	102°	,,	110°	,,
Very hot ,,	110°	,,	120°	,,
Hot-air[1] ,,	175°	,,	212°	,,

The Cold Bath.—The first effect of the cold bath is to produce a shock on the nerves of the skin. As a result the vessels of the skin become strongly contracted, the blood is driven out of them and seeks the deeper parts, which also will be suddenly excited by the rush of blood to them. Proof of this is found in the increased rate of the heart's beat and the quickening of the breathing. The temperature of the skin is reduced, but not that of the body as a whole, unless the immersion be prolonged. Indeed at first the internal production of heat is quickened by the stimulus to the internal organs. If, however, the application of the cold be prolonged the temperature of the body will be lowered, because water is a conductor of heat, and heat will be removed from the body more quickly than it is produced. For such a purpose cold baths are largely employed in Germany in cases of fever. The prolonged action produces depression, the action of the heart becoming feebler and slower, due to the action of the cold upon the nervous system as well as to the direct abstraction of heat. For recovery from such depression artificial aid, in the shape of hot blankets &c. and stimulants might be necessary. But in the case of the cold bath as ordinarily used, the application is short, and the more near to the temperature of 50° Fahr. the water is the shorter must it be. Following the first action is reaction, during which the blood returns to the skin, the blood-vessels of which relax, and a pleasant sensation of "glow," spreading rapidly over the surface, is experienced. This reaction is aided by rapid friction of the skin, as by towels, and if, after drying, the body is quickly clothed and exercise engaged in, the total effect of the bath is stimulating, inducing a feeling not only of warmth but also of vigour. The markedly stimulating effect on the various organs of the body is shown by the fact that the amount of carbonic acid gas given off from the lungs and of urea from the kidneys is increased, indicating increased tissue change, evidenced also by increased appetite. The length of time the cold may be applied without interfering with the setting in of a proper reaction depends upon the individual. A mere instant's immersion is sufficient for some, others can bear several minutes, while some could not bear complete immersion of the body at all, a feeling of coldness and shivering lasting for hours after it. Obviously for such persons the full cold bath is not suitable, but that does not necessarily imply that the use of cold water to the body is to them hurtful in every form. Much depends on habit, and a person unaccustomed to the full cold bath is not likely to find it pleasant without some preparation for it. This preparation can be given by the use of the cold wet towel &c. for some time, gradually leading up to the full cold plunge, which may thus be made tolerable and enjoyable.

The cold bath is not suitable for the old and the delicate. The shock is too great, and a proper reaction does not set in. Besides in delicate persons the rush of blood to the deeper organs may produce too great a strain upon weak parts. Of course old persons who have been accustomed all their lives to the cold bath need not break it off, if it continues to agree with them, or they may simply modify it by using some of the milder forms to be noted.

The action of cold may be intensified by pouring the water upon the body from a height, by causing it to fall upon the body with force as from a hose, or by showering it or spraying it on the body by the use of various arrangements of pipes &c.

The morning or early part of the day is the suitable time for such kinds of baths. Persons who are thus habituated to the use of cold water are less susceptible to the influence of cold and can stand longer exposure than others.

The Wet Sponge is the mildest method of using cold water, and is well adapted for the weak and delicate. The body may simply be rapidly sponged over, or the person may stand or sit in a large shallow bath, and the water be squeezed from a sponge over the shoulders and body. This may be done in a warm room, the water in which the person stands being warmer than that from the sponge. After one application of the cold water, the person is quickly dried and dressed. At first the water in which the sponge is dipped should be tepid, and day after day may be used colder, as the person becomes accustomed to it, till quite cold water is used.

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[1] This degree of temperature is of course unbearable unless the air is dry, and the explanation of its being borne is given on p. 735.

The Wet Towel is not quite so mild as the sponge. The towel is dipped in water of the desired degree of coldness, wrung lightly out and applied to the body, which is then vigorously rubbed with it.

The Wet Sheet is still less mild. The whole body is enveloped by the sheet, and rubbed up and down for several minutes. The wet sponge, wet towel, and wet sheet, may be used as stages in accustoming the body to the employment of cold water, preparatory to the trial of the ordinary cold bath; and the degree of coldness of the water and length of time of application can be regulated according to the effects produced.

Tepid Baths produce neither depression nor excitement, and are therefore suited for all. They are the best when prolonged immersion is desired, as in the treatment of chronic skin and nervous diseases.

The Warm Bath is particularly serviceable in removing feelings of fatigue. It should quicken only slightly the circulation, and bring an additional quantity of blood to the skin. It is by this means that it removes the tired feeling from exhausted muscles, for it promotes the removal from the tissues of the waste products, which have accumulated during the period of activity, whose presence in the muscles is the cause of the feeling of weariness. After prolonged labour, or a long fatiguing walk, or prolonged exposure to damp and cold, or after, for example, the exertion of much dancing, nothing is so restorative and refreshing as a warm bath. After such exertion many persons are restless, and desiring repose cannot find it owing to sheer weariness. A full warm bath, prolonged for fifteen or twenty minutes, will remove the ache from the muscles and substitute a feeling of quietness conducive to sleep. It is also capable of restoring the body to a condition in which renewed activity is possible with comfort. When employed for such purposes, the person should end with a spray or douche, or simple sponge of tepid water (70°) if he is about to go to bed, or with a warm spray, quickly reduced to cold, before dressing to go out.

Warm baths are largely employed in feverish affections of children, for promoting the action of the skin; and they are a safe resort in the convulsions of children, cold being at the same time applied to the head.

The Hot Bath acts in a more pronounced way upon the heart and nervous system than the merely warm bath. If very hot it powerfully excites the heart, whose action, indeed, it may stimulate to violence. The brain is also influenced by the more copious flow of blood through it, due to the vigorous action of the heart. These effects, however, are largely counterbalanced by the increased flow of blood to the skin. But the prolonged use of hot baths is weakening, and the temporary strain thrown upon the heart and blood-vessels and brain would be hurtful to many. The bather should be immersed to the chin; the hair is damped with cold water, and a thin cold cloth is wrapped about the head. Cold water may be drunk if desired. The bath should last twenty minutes, or less if oppression is felt. It should conclude, as directed for warm bath, with tepid douche or sponging, or with warm spray quickly reduced to cold. The hot bath should not be used in the morning or early part of the day, or at any time except before going to bed, unless the person is properly cooled down before dressing and going out.

Warm baths are valuable means of reducing excitement, and relaxing spasm, such as the temporary spasm causing inability to empty the bladder.

The Hot-air Bath is one of the most powerful ways of stimulating the activity of the skin. The person, unclothed, is placed in an apartment heated by means of furnaces, the air being dry. In a longer or shorter time, according to the heat of the air and the condition of the bather, the perspiration bursts out upon the skin, becoming very copious, so that the whole body is bathed in sweat. A very high temperature may be borne so long as the air is quite dry, for the sweat passes rapidly off from the body in the form of vapour, removing a large quantity of heat, and thus the temperature of the body does not rise, unless the air is very hot, when the heat of the body usually increases by two or three degrees. The same high temperature could not be borne if the air were moist, as in the case of a vapour bath, for then the air is saturated or nearly so with moisture and cannot take up more, or can take up very little.

In this case the sweat does not readily pass off from the body, and the regulating action of the skin on the heat of the body is interfered with. Marked oppression, difficulty of breathing, fulness in the head, faintness &c. would then speedily arise. When the air is quite dry, however, a high temperature, for example, that of 180° Fahr. can usually be endured with ease, and even above 212°. Not only the activity of the skin, but the action of the heart and of breathing are greatly increased. It is thus not suited for everyone, certainly not in its full form for anyone with weak heart or vessels, and for very full-blooded persons. The hot-air bath may also be given in a box heated with gas or spirit-lamps.

The Turkish Bath.—The hot-air bath is usually obtained with other accessories in the form of the Turkish bath. This bath was adopted by the Turks from the Romans, who derived it from the Greeks. The ordinary method, as used in this country, is well known, and the general arrangements need be but briefly mentioned. The bather enters the dressing-room (Roman *Vestiarium*) which is heated to an ordinarily comfortable temperature. Round the wall are stalls, curtained in front, and each provided with a couch. Beyond this room there are, in the fully-equipped Turkish baths, three rooms, separated from the dressing-room by well-padded doors. The first of these corresponds to the Roman *Tepidarium*, the warm room, in which the temperature is from 115° to 120°; beyond this and separated from it by heavy curtains is the hot room, or *Calidarium*, in which the temperature ranges from 120° to 140°; and still beyond is the hottest room, called also the flue room, corresponding to the Roman *Laconicum*. Here the temperature is not below 150°, usually 175° to 180°, but may be 200° and upwards. Every Turkish bath has certainly two rooms beyond the dressing-room, one in which the temperature may readily be raised to 140° or thereby, and one beyond it in which the highest temperatures may be obtained. The heating is accomplished by flues, beneath the flue-room, the other rooms being heated from it as well as by means of heated fresh air, admitted through appropriate openings. The flue from the furnace passes underneath the floor of the hottest room, and enters a coil of cast-iron pipes, coiling along three sides of the room, the walls of which are formed of glazed brickwork.

A most important point in the construction of a Turkish bath is the arrangement for ventilation. The great rapidity with which evaporation takes place from the body, subject to the high temperature of dry air, would speedily cause the atmosphere of the rooms to be impregnated with emanations from the skin, which would be inhaled by the bathers unless some very efficient means existed of removing the polluted air and substituting fresh warm air. This is of vital importance, and is necessary also for another reason, namely that the evaporation of sweat from the body renders the atmosphere moist. Now the air of the Turkish bath ought to be perfectly dry, and therefore the continual removal of moist and polluted air and its replacement by perfectly dry and pure hot air are necessary. This is now accomplished, in the best baths, by utilizing the draught in the exhaust flue of the furnace. The foul air is drawn *from the floor*, for it is near the floor the foul air collects, since it is less warm than the entering hot air, and is heavier by reason of the moisture and impurities it contains, and passing through pipes along the side of the bath reaches the chimney. Any arrangement which seeks to ventilate from the roof defeats its own ends, since the fresh hot air rises and will be drawn off, while the polluted air will be left.

In the warm rooms the bather reclines on a zigzag wooden chair, over which he spreads his dry bath-towel. In the hottest room the floors require strips of matting, or felt slippers are worn, to protect the feet. Wooden chairs are not admissible, on account of the great heat, and the best form of chair is one with canvas seat and back, which are easily cleaned by washing.

Convenient to the warm rooms is an apartment moderately heated and provided with low tables of marble, corresponding to the Roman *Lavatorium*. On one of these the bather lies down and is rubbed or shampooed by the bath attendant, soaped and scrubbed, and finally douched first with warm and afterwards with cold water, preparatory to a return to the dressing-room, as described later.

These being the general details of a Turkish-bath house, it will be well to describe the regular course of the bath itself; and we shall first of all describe the full bath as taken by anyone with whom time is no consideration, in a bath with three rooms of increasing heat.

The Full Bath.—The bather undresses in one of the curtained recesses of the dressing-room, girds a towel or similar contrivance round his loins, and carrying a bath-towel over the arm passes into the warm room. Here he stays only long enough to wet the hair with cold water, and perhaps drink of it, and then passes on, straight through the hot room, into the hottest room. Spreading his towel over a chair he reclines upon it, talking little or not at all, wets his head with cold water, and drinks at his pleasure, but not too copiously, of cold water, which the attendant will bring him. Here he remains five or ten minutes. By this time the whole body will be bedewed with perspiration; and the bather passes out into the room next in temperature, the hot room, where he reclines for another ten or fifteen minutes. Then he passes to the warm room, lower in temperature than the former, and here he reclines till the attendant is ready for him, when he proceeds to the washing room. Here he lies on a table and the attendant goes over the whole body, rubbing the surface, and thus removing all loose effete skin, grasping and kneading muscles, bending joints and so on. He is then rubbed over with soap, scrubbed and washed down, and lastly douched with warm and then tepid and cold water. From this room the bather passes out quickly, plunges through a cold bath, and regains the dressing-room, where he is quickly dried down with warm dry towels. He is then enveloped in a dry bath-towel, and so attired he lies down on his couch in the dressing-room, covered over with a light rug or blanket, till his skin assumes its natural degree of warmth. Here the soothing influence of the bath proclaims itself, by the tendency to sleep which it induces, which should not be yielded to, however, because of its relaxing effect. When the skin is cool and dry, usually in fifteen or twenty minutes, the bather dresses quietly and deliberately. It is important that he should rest a sufficient time to be quite cooled down before he dresses, lest a second perspiration be induced as soon as he walks abroad, leading to a chill. At the same time he must not rest so long as to become chilly. Each bather should be able to determine by his own sensations, when is a suitable time to dress. Employed in such a way as has been described, the Turkish bath is not only unexcelled for its purifying effects, but is a wonderful restorative after fatigue, and imparts a delightful sense of lightness and buoyancy.

Now it may be pointed out that this order of taking the different rooms, the hottest first, and thereafter those of a lower temperature, is advised because a few minutes of the dry air of the hottest room will bring out the perspiration, as a rule, quickly, and will thus speedily relieve the strain on the heart and other organs. Once the perspiration is fully out it is easily kept up by a lower temperature, and hence the return to the room of lower temperature does not arrest it. On the other hand if one stays in the hot room till the perspiration is well out, and thence passes to the hottest room, a drying effect is apt to be produced. In the hot rooms the temperature of the body rises, one or two degrees, till the perspiration breaks out, by the evaporation of which it is prevented rising higher.

Taking the order of the bath as has been here given, many people entertain considerably divergent views as to the degree of heat that is desirable in the hottest or flue room, some being unsatisfied if 200° or even 212° is not reached, others seeking to have it about 175°, and others still lower. Concerning this point Dr. W. B. Hunter, of Matlock, makes the following remarks:—"It is no exaggeration to declare that the customary practice of a public bath has for its aim and ideal the endurance of the greatest possible temperature for the longest possible time. This is a truly simple ideal, and there is a certain simplicity likewise in those who strive after it. The result, on the contrary, is otherwise, and to such as are not gifted with an exceptional constitution and superabundance of vitality, the strain it involves brings much of mischief along with the benefits inherent to the bath. It entails in time an enfeeblement as marked as that invigoration which a more moderate use of the bath most surely affords.

"With the thermometer no higher than 103°, when one foot only from the floor level (at the customary height of five feet it was 115°), a copious perspiration was maintained for a period of forty minutes. The pulse meanwhile was soft, and never got above 84 beats per minute; the respiration was quiet and stood at 12½ per minute throughout, and the heat of the body, as observed by a clinical thermometer, kept close from beginning to end in the axilla (armpit) never got above 98·6°, an elevation no more than two-tenths of a degree beyond the normal. This should serve to show how little may be necessary, after all, for attaining to the full the principal object the bather has in view, and how slight need be the strain involved in its maintenance—an irreducible minimum, it might fairly be called. While recording these observations, note was made at the same time of the lot of a fellow experimenter who took his place in an adjoining room where the temperature registered as high as 156° though fixed but one foot above the floor level. The limits of physical endurance were reached with him in the space of twenty-five minutes only, whilst, with no greater evidence of perspiration at any stage than was forthcoming at the modest temperature aforementioned, the pulse had gone up to 116, the respirations to 21, and the bodily heat to 103°. The palpitation, giddiness, and prostration, which thereupon compelled his retreat to the cooler chamber, subsided almost at once, and the pulse fell immediately to 102. Both experimenters were fairly representative, because habituated to the use of the Turkish bath; and subsequent observations were, in every point, confirmatory of this one. An extensive acquaintance with the bath in almost every variety of case and constitution has led the writer to adopt 135°, the thermometer standing at a level of 3 feet, as the maximum temperature proper for ordinary use in the average subject. From 115° to 120° is the temperature proper for the feebler order of patient, the hyper-sensitive also, and as the first or introductory bath for such as are not unmistakably robust, and free from the suspicion of anticipatory nervousness. For the regular *habitués* of public baths, on the other hand, an initial temperature of 170° is at worst but a harmless indulgence, provided it be not endured beyond the bounds of comfort, and is exchanged at once for a lower, as rational observation may suggest."

"That there are some who find themselves equal to encountering much higher temperatures than this, for a time, is not to be denied, but that such powers of endurance are exceptional, and the occasion for their exercise more exceptional still, is the teaching of experience to one whose opportunities of noting results have not been limited to a few cases, nor to the immediate occasion."

The ordinary duration of the full bath, from the flue room to the washing room, is from forty minutes to an hour. The time may be curtailed thus: flue room five minutes, hot room fifteen minutes, warm room ten minutes, and the remainder as directed.

Various modifications may be introduced. If the bath be taken only occasionally, the shampooing and soaping are desirable thoroughly to cleanse and stimulate the skin. If it be taken more frequently, as in a course of the baths, the shampooing and soaping may be dispensed with, except once or twice a week, and from the warm room one may pass to the washing room merely to be sluiced and douched. Again, after the washing, one may have a warm followed by a cold douche, and then pass straight to the dressing-room, without the cold plunge.

The full bath, however, though slightly modified in this way, is suited chiefly for those accustomed to it, and for the healthy and robust. For those, unaccustomed to it, a briefer form of bath is preferable as a preparation, for the first one or two occasions, and may be the only advisable form for those not quite robust.

The Brief Turkish Bath begins with the hot room, not the hottest or flue room, where the bather stays for ten minutes or thereby. The warm room is then entered for other ten minutes, and thereafter the bather proceeds to the washing room, ending as already described.

Many bathers never use the hottest room at all, remaining in the hot room twenty-five minutes or more or until profuse perspiration is excited, and passing through the remainder as described.

The Mild Bath consists in spending twenty to thirty minutes in the warm room only, thence the bather passes to the washing room. This is the form for the very old, the very young, and for invalids.

Some persons do not readily sweat in the warm room. If so they should not enter the very hot room. At first at least they should be content with the warm room, and after several trials the skin may be got to act more fully, when the very hot room may be borne. Difficulty in perspiring is held to be an indication for the need of the Turkish bath, rather than the reverse, an indication that the skin is not discharging its functions duly, and that this, the most powerful means of re-establishing it, will be followed by specially beneficial effects. When any real difficulty exists, an expert attendant is likely to be able to overcome it, if necessary by the use of a hot soaping bath for a day or two, or other means.

The Vapour Bath acts upon the body much as the hot-water bath does, but it acts more powerfully, though the effect of the heat is not so quick since vapour is a slower conductor of heat than water. This bath can, therefore, be borne hotter than a water bath, but the high temperature cannot be borne long, for the vapour does not permit of the loss of heat from the body as hot air does. The temperature of the vapour bath cannot be comfortably endured above 120° Fahr. The vapour bath is characteristic of the Russian baths. It is taken in a chamber filled with vapour, which is thus not only applied to the surface of the body but also inhaled. This makes it still more oppressive. It may be used, however, in a simple form, in which the vapour is not breathed, by the person sitting on a chair, inclosed within a box, an opening in the lid of which permits the head being outside. This form of bath can readily be improvised anywhere. It is only necessary to seat the person naked on a chair, and surround him from the neck downwards by blankets, which envelop the chair also and hang to the ground. Under the chair is placed a shallow earthenware or metal dish, containing boiling water to the depth of 3 or 4 inches. Into the water are placed a couple of red-hot bricks. Or under the chair may be placed a spirit-lamp, supported above it being a shallow pan containing boiling water. A simple apparatus for such baths is in the market. Such baths are very useful for catarrh, for rheumatic and neuralgic pains, sciatica &c., as well as for cases where excessive action of the skin is desired to relieve deeper organs, for example the kidneys.—Ten to fifteen minutes are long enough for exposure in the vapour bath.

Sea-bathing.—Ordinary sea-bathing is of course cold, and produces the stimulating effects which have been described in the paragraphs devoted to the cold bath. There is besides the additional stimulus due to the salt, so that sea-bathing acts as an invigorating tonic. It is not, however, suited for everyone, and is taken much too indiscriminately. It is also indulged in without due precaution. It is a very common error for persons to remain in the sea too long. The townsman, as soon as he gets to the watering-place for his well-earned holiday, hastens to take a swim; and, if he is in company, thinks he ought to remain in the water as long as his companions, who, it may be, have been regular bathers for some time previously. He is somewhat disgusted on coming out to find himself shivering, and to notice the blueness of his skin, finds it difficult to get on and arrange his dress, because of stiff fingers, and cannot readily get up heat again, while his companions are glowing with warmth and vigour. He has stayed too long; depression has occurred and reaction is slow to set in. He may be giddy and threatened with headache, from excess of blood to the head. He is prone to conclude, or his companions to conclude for him, that sea-bathing does not suit him, and perhaps he is tempted to give it up. The proper course is for him next day to greatly shorten the length of his stay in the water. He ought simply to plunge in, come out quickly, and after a vigorous rub dress rapidly. Next day this may be repeated. If he finds reaction now readily sets in, he may prolong his bath by a minute the succeeding day, and thus gradually accustom his body to the bath, till he can equal his companions in the length of the bathe. Persons who are anaemic—that is, of deficient quality of blood—ought not to indulge in sea-bathing without advice, and failing advice had better try first a salt-water bath at home. Persons who have suffered from any internal complaint ought also to refrain.

The best time for sea-bathing is in the morning. It should never be indulged in immediately after a meal, when the business of digestion is going actively forward. Indigestion, cramp in the stomach, headache and so on are almost certain to ensue. If it be not taken before breakfast, a good time is before lunch or early dinner, for which the brisk walk home after the bathe will prove an excellent appetizer. Neither should sea-bathing be engaged in immediately after very active exercise when the body is in a state of very active perspiration or in a condition of fatigue. At the same time, moderate exercise before the bath is unobjectionable, and the body ought to be comfortably warm. The person should not wait till he has become perceptibly cool, but should undress quickly and plunge in bodily, wetting the whole body at once. Wading in to deep water is undesirable, the distribution of blood being upset by the cold water driving it upwards as one advances to deeper water. During the bath exercise should be active, as in continued swimming.

It should be remembered that children, because of the little-resisting power of their young bodies, are very readily depressed by sea-bathing, and are not to be subjected to it as a matter of course. By bathing at home, by wading, which they usually enjoy, they may be gradually accustomed to it; but they ought not to be forcibly immersed to their aversion and terror.

Sea baths may be imitated at home by the addition of common salt or sea salt to water. About 9 lbs. of salt to 30 gallons of water is a quantity commonly used. These are useful for children and specially for such as are of a scrofulous habit of body. For such sea-water is also used at home, after being warmed to any required degree.

River-bathing is less stimulating than sea-bathing because of the absence of the saline constituents of the water. The general rules applicable to sea-bathing are applicable to such fresh-water baths.

The benefits of open-air bathing—sea or river—are not limited, of course, to the action of the water but are increased by the action of the fresh air, the respiration of which is stimulated by the bath, and by the active exercise in the open air invariably indulged in afterwards.

Medicated Baths.—There are many kinds of baths which have, or are supposed to have, special properties, valuable for diseased conditions, because of containing various saline substances dissolved in them. Such baths may be artificially prepared by the addition of the salts to the water, or natural mineral waters may be used for the purpose. Thus there is the **alkaline bath**, made by adding 6 ounces of crystallized carbonate of soda or 3 ounces of carbonate of potash to 25 or 30 gallons of water, a very useful bath in irritable diseases of the skin, such as itching, eczema &c. There is the **sulphur bath**, made by dissolving 4 to 8 ounces of sulphuret of potassium in 25 to 30 gallons of water, also useful in skin affections. **Pine baths** are made by adding some of the pine extract to the bath water. Extract made from the leaves of the pine is made and sold for this purpose, about a pound being the quantity added. A recent preparation—the extract of pumiline pine—is used for a similar purpose. They are employed in gouty and rheumatic cases and also for irritable conditions of the skin.

The **Mustard-bath** is made by adding a handful or more of mustard to the ordinary warm bath. It is seldom, however, used for a full bath, but is mainly employed as a foot-bath, for which one or two tea-spoonfuls of mustard are sufficient. The mustard foot-bath is a favourite and useful domestic method for warding off the effects of cold, combined with a hot drink and a warm bed. It is an exceedingly speedy method of withdrawing blood from other parts of the body. It will wonderfully relieve the throbbing headache of the congestive kind, and it may quite safely be used in the convulsions of children, their legs being dipped into it, and kept there till the skin is quite red.

It is not necessary to enumerate the various natural mineral waters, which are used for bathing purposes as well as for internal consumption. Some of them are considered in the sections devoted to drugs. It is only necessary to recall what has been said on p. 310 in reference to the very slight power possessed by the skin of absorbing substances. Any influence medicated baths are likely to have is not, therefore, due to the contained salts passing into the circulation, but to the temperature of the water, and the remote effects on nerves, heart, breathing &c. that, as already explained at the beginning of these paragraphs, may be so induced, and to the local effects on the skin, which will undoubtedly be influenced by the substances the waters contain in solution.

Mud-baths made of a muddy kind of earth found specially at Franzenbad in Bohemia, and used also at Carlsbad and Marienbad, also in Bohemia, are found useful in irritable conditions of skin, as well as in conditions of nervous excitement and in rheumatic affections. The earth is mixed with water from the mineral spring till it is throughout of a soft poultice-like consistence, a bath-tub is then filled with it, in which the patient sits, up to the neck, for about twenty minutes, after which the mud is removed by a clean water bath.

Various arrangements are employed for accentuating the effect of the water, whether used hot or cold, or for applying it to particular parts of the body.

The Douche is a jet of water directed upon some part of the body through a 1½-inch pipe, the force of the water, quantity discharged, and temperature being capable of modification. It at first lowers the vitality of the part to which it is applied, but reaction sets in quickly, so that its whole effect is stimulating, quickening tissue change. The douche may be used hot or cold, or one after the other in rapid succession, a change which is most stimulating of all. In old-standing complaints, thickenings about joints, for stiff joints &c. it is a very useful application. In the case of the descending douche, the pipe is 10 to 15 feet above the floor level, and for the horizontal douche the pipe is 4 feet above floor level. In the former case it is played first on the spine, and then shoulders, hips, arms and legs in succession. At the close it is directed on to the chest and head, the force of the water being broken by the hands. In the latter case the back, chest, arms, and legs are douched in the order named, while the patient rubs himself vigorously. Before beginning the head is wetted with cold water, and is douched last, the force of the water being broken.—The process should last from one to two minutes.

The Spray may be used hot (100° Fahr.) for half a minute, and then gradually becomes cold for two or three minutes, while the patient turns round, rubbing himself vigorously, the head getting its share. If used simply warm (90° Fahr.) and reduced to tepid (70° F.) slowly, it is milder. The **Rain-bath** is an overhead spray, and is used as described for the latter. The **Ascending Spray**, as a stimulant to the lower bowel, may be used cold for half a minute, or tepid for one or two minutes, or beginning warm and becoming as hot as can be borne (105° to 120°) for two or three minutes, or hot and cold alternately, beginning warm (90°) gradually raised as hot as is bearable, then gradually reduced to cold, and raised again to be reduced once more, during a period of four minutes.

The Needle-bath is simply a fine shower-bath, arranged circularly so that the fine streams of water converge upon the body, the multitude of fine streams having a more stimulating effect than a simple dash of a mass of water would have.

The Sitz-bath or **Hip-bath** is a means of limiting the application of the water to the hips, buttocks and neighbouring parts. The form of the bathing-tub is such that the person has the bath in the sitting posture, the limbs and upper part of the body being out of the bath. When used as hot as can be borne, the bath is half filled with water at 100°. The patient sits down in it, on a hot flannel pad, another being placed on the back of the bath, the feet, outside of the sitz-bath, being immersed in a foot-bath of water at the same temperature. The patient is then enveloped in warm blankets from the neck, a thin cloth, wetted with cold water, being tightly wrapped round the head. After a few minutes, a pint or so of boiling water is poured slowly against the side of the bath, and this is continued from time to time till the water is as hot as can be borne (110° to 120°), sufficient water from the middle of the bath being removed to keep the level of water an inch below the bath brim. In twenty minutes the patient stands up and is sponged over with water at 80°. The cold sitz-bath should last only two or three minutes.

The sitz-bath, hot or cold according to circumstances, is in much use for abdominal and liver complaints, and specially for feminine ailments. Its soothing effects, when used hot, in painful and spasmodic disorders of bowels, bladder, and womb, are very marked.

The **Full Pack** is directed to be given as follows: On a bed or packing couch spread lengthwise three blankets, large and thick; and upon these a thin linen sheet wrung well out of cold water, its upper margin folded short of that of the blankets by half a foot or so. The patient lies down undressed on the sheet with arms close to sides, the head just beyond the upper margin of the sheet, the feet well within the lower, and so wrapped up in it quickly, one side after another, the neck and feet with special care. The blankets next, each in turn, are, side after side, tucked round about and beneath the body, smoothly and lightly, the spare blanket beyond the feet doubled back beneath. On the top of all put the bed-clothes, lightly pushing them under on each side, and lay the pillows, one lengthways on the body, the other across the legs, leaving the bolster alone beneath the head. Put a cold wet cloth round the head, a hot-water bottle to the feet, and give cold water to drink as desired. The window should then be opened—there being nothing in the case to the contrary—and sleep favoured. Let the patient remain thus for one hour. If the hot pack is given, the sheet is wrung out of boiling water, and kept coiled up till required.

This form of bath is a gentle but very efficient method of stimulating the skin and producing perspiration. It is in much use in feverish complaints, and is very valuable in "determining to the skin" in eruptive diseases like measles or scarlet fever. For calming excitement and restlessness, and inducing sleep it is also exceedingly useful; and it affords marked relief to the kidneys.

The Use of Baths in Disease.—The value of baths of various kinds in disease has been alluded to, by the way, in the preceding paragraphs. As an agent in the maintenance of health the bath is a necessity. As a means of restoring vigorous health to those who, without being the subjects of any actual disease, are yet "down" in general health, as the result of prolonged overwork, anxiety &c., it is an agent of great power. The stimulating and invigorating action of the cold bath has been sufficiently spoken of, and the soothing and sleep-persuading effects of judiciously-given warm baths have also been referred to. The treatment of actual diseased conditions by baths in association with rational treatment by medicines is an art requiring the knowledge and discretion of the skilled physician, applied to each particular case, and it is not, therefore, possible to state here rules, which can take the place of such active superintendence. It may be noted, however, that rheumatic and gouty disorders, chronic affections of the skin, digestive derangements, especially such as are associated with sluggish conditions of the abdominal organs (sluggish liver, constipation &c.), are among those in which the treatment by baths yields the most surprising and gratifying results.

In particular the Turkish bath, when administered not at random but under skilled superintendence, and in a degree suited to the strength and age of the person, is fitted to produce results far more effective than is generally recognized. The reason is quite readily understood. These diseases are mainly those of bad general nutrition, dependent to a large extent on a bad quality of blood or to a bad distribution of blood. The free stimulation of the skin, which is produced, not only rids the blood directly of much effete material, which, in the case of gout and rheumatism, is at the bottom of the disorder, but also indirectly by the secondary effect on the other organs for removing waste, such as liver and kidneys. The improved condition of blood which results will profoundly affect every organ and tissue of the body. Similarly the redistribution of blood will relieve organs unduly charged with blood, and will induce a better supply to others which formerly enjoyed too little. Engorged conditions of liver and kidneys, catarrhal states of the air-passages, as in bronchitis, of the urinary passages, and of stomach and bowels, are markedly benefited by such changes. The effect of the withdrawal from the blood of the large quantity of water, which occurs during the exposure to the dry hot air of the bath, is found to be markedly beneficial in cases where there is an accumulation of fluid in some of the cavities of the body, as in the various forms of dropsy, while the absorbent system of vessels is also stimulated to the removal of the results of inflammatory swellings and thickenings. Nervous disorders, hysteria, neuralgia, nervous headache, sleeplessness, and so on, ought to be greatly influenced by a judicious use of such baths. Especially will this be so, if to the calming effect, produced by the withdrawal of blood from the central nervous organs to the skin, there be added the bracing and tonic effects of the spray, douche, &c., hot and cold, as may be appropriate to the case, combined with the powerful stimulus to improved nutrition which can be brought to bear by massage.

In particular it ought to be noted by anyone, to whom a Turkish bath is easily accessible, that it is of signal service in simple chills. At the outset of an ordinary cold, it will often prove an effective check, as well as to the ordinary stomach and liver disturbance, common to many as the result of cold.

While anyone may resort to the Turkish bath, at his own discretion, to ward off the effects of a suspected chill, or to cut short a simple cold, it should not be indiscriminately tried, it must again be said, for the graver disorders of lungs, kidneys, &c. For these cases competent advice and supervision should always be sought.

The value of the hot or cold bath, and similar substitutes for the Turkish bath, in eruptive fevers, has already been remarked on. On the Continent cold baths for the reduction of high temperature, specially in typhoid fever, are in extensive use.

Is the Turkish bath not weakening? is a question one hears very often put in a tone of voice that implies little doubt that it is so. If the explanations that have been offered as to the action of the bath have been understood, one will be prepared for the answer that, instead of being weakening, it is invigorating, *when properly employed.* If a man be weighed immediately after a Turkish bath, he will have lost weight undoubtedly, by the quantity of water and its dissolved salts, &c., and the amount of carbonic acid gas, &c., that have escaped from his skin and lungs—water and waste products, that is to say. The loss of water is easily made good, if that be necessary. The temporary loss of weight is a mere incident, however; the real and essential results are the quickened circulation, the redistribution of blood to the various parts of the body, the stimulation of various organs, and the sweeping out of the body of effete and hurtful materials. The results of these changes are speedily apparent in a feeling of freshness and lightness, and within a few days in increased appetite, because of improved digestion and absorption of food. This is the explanation of the fact that within a few days of commencing a course of baths, a person begins actually to add to his weight and to be aware of increased bodily vigour, provided appropriate food and exercise have reinforced the action of the bath. As a matter of fact repeated weighing is made use of in the best-conducted baths as an indication of the effects being produced. In cases of corpulence, of course, loss of weight is desired, but it is loss of weight by reduction of fat only, not by reduction of muscle. Indeed the corpulent patient needs not only to lose fat, but, as a rule, also to *build up* muscle. This process, also, the bath will aid, but, again, only when associated with proper dieting and exercise. In such cases it promotes the loss of weight in the same way that in others it promotes a gain of weight, namely by restoring the normal process of healthy nutrition, enfeebled in the latter class of cases and perverted in the former.

SECTION VI.—EXERCISE.

Effects of Exercise:
- *Effects of Exercise on Muscles;*
- *Effects on the Heart and Circulation;*
- *Effects on the Breathing;*
- *Effects on the Digestive Organs, on the Skin and Kidneys;*
- *Effects on the Nervous System.*

Excessive and Defective Exercise.

Various Forms of Exercise:
- *Walking*—The Expenditure of Energy involved in Walking and Climbing—Proper Daily Amount of Walking—Exercise for Girls and Children;
- *Running*—Training for Running;
- *Jumping;*
- *Rowing;*
- *Lawn Tennis;*
- *Bicycling and Tricycling;*
- *Cricket, Football, and Golf;*

Gymnastic Exercises:
- *Exercises without Apparatus*—Exercises for arm, head, body, and leg, adapted for children;
- *Exercises with Dumb-bells, Bar-bells, and Hoops.*

Exercises in the Treatment of Disease:
- *Massage.*

Effects of Exercise.—We use the term exercise, as regards the body, to mean the use to which the various organs of the body are put. Thus we speak of exercising the voice, of exercising the brain, of exercising the faculty of reason, or judgment, or imagination, and we speak of exercising the muscles of the body as in walking, running, riding and so on. It is specially in the last sense that it is made use of in the following paragraphs, the use or employment of the muscles, voluntarily, in the various actions by which external work is done, as in walking, &c., the various kinds of manual labour, and in pastimes such as football, tennis, &c. In these exercises we put the various voluntary muscles of the body into action, and we shall best understand how profoundly such action affects the whole body if we consider how such action affects a muscle and what changes are promoted in it thereby.

The structure of voluntary muscle has been described in Pt. I. (Section III. A.), and its chemical constitution and properties have been indicated. We may recall the facts that a muscle consists of a number of fibres of living material in which chemical changes go on, that when the muscular substance is irritated it contracts or shortens itself, and that it may be irritated by a stimulus applied directly to the muscular substance itself, or by the stimulus given to it by the nerve in connection with it, the usual way in which muscle is caused to contract. While it is in a living state the muscular substance is always undergoing chemical changes. These changes are of the nature of oxidation or combustion, for by them oxygen disappears and carbonic acid gas is produced; that is to say, oxygen unites with substances in the muscle containing carbon, the union of the two substances causing the disappearance of oxygen and the appearance of carbonic acid gas. At the same time heat is produced, just as heat results from the union of the carbon of coal or wood with the oxygen of air in a grate (p. 527). When a muscle contracts, these changes are increased, a greater quantity of oxygen is used up, and a greater quantity of carbonic acid gas and heat is the result, and the more active the contraction of muscle is the greater is the increase in these changes. Moreover it has been shown that, as another result of contraction, more water is contained in muscle than is found in a state of rest. Water, we have seen, consists of hydrogen and oxygen, and the meaning of the increase in the quantity of water is that some substances, contained in the muscle, have been made to yield up hydrogen to combine with oxygen. In short, as a result of the activity of the muscle, certain complex chemical compounds have been broken down, and the carbon and oxygen they contained have united with oxygen to yield carbonic acid gas and water. As a result of this process of decomposition other chemical substances are formed, for after contraction the muscular substance is found to be acid, while at rest it is not so, and the acidity is due to the presence of an acid, called paralactic acid, and of free phosphoric acid. These facts are all indications that in an actively contracting muscle chemical transformations are occurring, by which complex chemical bodies are broken down, of which carbonic acid gas, water, paralactic acid and other substances are the by-products or waste products. These changes can be shown to occur in a muscle separated from the body, in a muscle separated from the body of a newly-killed frog, for example, which can be made to contract for a very considerable time, after its removal, by stimulating with a current of electricity. It has been established by experiments, which it is not necessary to detail here, that such changes can go on not only at the expense of substances *contained in the muscle*, but also at the expense *of the muscular substance itself*. We, therefore, notice these two facts (1) that by exercise a breaking down of material stored up in the muscle and of the muscular tissue itself occurs, implying the necessity for the introduction of new material for repair, and (2) the formation of waste products occurs implying some arrangement for their removal. The fatigue of muscle, meaning a diminished power of contraction or, if excessive, temporary loss of power to contract longer, such, for example, as causes a person, who has taken a very long walk, to feel as if he could hardly move another step, and produces the tired, wearied, and aching sensation in his limbs, fatigue of muscle is due both to this consumption of material, not sufficiently counterbalanced by repair, and to the accumulation of waste products, which have been produced more quickly than they could be removed. It is probable that it is the accumulation of the waste products in particular that causes the tired sensations of fatigued muscles, and that rubbing of the limbs, the use of a hot bath, &c., greatly diminish these feelings because they help the speedy removal from the muscles of the waste substances. In ordinary circumstances material for the repair of wasted muscular substances is brought to the muscle, and the products of waste are removed, by the blood flowing through the muscle. Blood is brought to the muscle by the arteries which supply it, and it carries with it nourishing material for the rebuilding of the broken-down tissue and oxygen to replace that which has disappeared. The blood, after flowing through the muscle passes away by the veins, and it passes away poorer than it was when it came by the amount of nourishing material and of oxygen it has given up for repair, and less pure than when it arrived by the amount of carbonic acid gas and other waste products it carries off with it. This is shown by the fact that the blood—the venous blood—passing away from an active muscle is poorer in oxygen and contains more carbonic acid gas than the blood flowing to the muscle. Further, to meet the demand created by the activity of the muscle the circulation of the blood through it is more active than when it is in a state of rest, and, as another indication of the chemical changes going on, the heat of the blood is increased after its passage through the muscle.

If, instead of limiting our view to the results of the contraction of one muscle, we reflect what must be the consequences of the activity of a large number of muscles, as is necessary for walking, and still more pronounced in running, in cricketing, in boating, &c., we shall begin to realize how great must be the effect upon the whole body by the increased activity of the circulation induced, by the greatly increased demand for nutritive material for repair, by the call for more oxygen to effect the increased chemical changes, by the stimulation of the kidneys, lungs, and skin that subsequently results from the increased waste products thrown into the blood, which it is the business of these organs to remove, and we begin to perceive how it is that the exercise has a marked influence not only on the muscles called into play, but an immediate and stimulating effect upon every other organ of the body. As to the muscles themselves, the effects of exercise, always supposing it not to be excessive, are still greater than have been referred to. It is not only that substances in the muscle have been broken down and cast off, and that new substances have been built up to take their place. The stimulus to nutrition which the exercise has produced affects every part of the muscle, and not only those substances in it or of it, involved in the chemical changes. Every fibre of it shares in the benefits of the increased flow of the nutritious fluid through it, and increased size and vigour of the fibres, and, it may be, the production of new fibres, are directly encouraged. Not only does the movement of the muscle and the quickened flow of blood through it serve to remove the waste matters produced by the activity of the moment, but effete material, formerly produced, whose retention in the muscle has been encouraged by a period of comparative inaction, is now swept out. Thus the muscle is strengthened by the formation of new material in increased amount and reinvigorated by the cleansing process to which it is subjected. On the other hand, if for a season, more or less prolonged, little exercise is indulged in, the lessened activity of the muscles implies diminished circulation throughout them, and a falling off in muscular vigour and actual decrease in the bulk of the muscles, through wasting or atrophy. These are illustrations of these facts familiar to every one.

> "The smith, a mighty man is he,
> With large and sinewy hands;
> And the muscles of his brawny arms
> Are strong as iron bands."

The relation between the regular methodical use or exercise of his arms by the village blacksmith and the strength and firmness of the muscles is appreciated by every one. On the other hand most of us know that if the smith were, unfortunately, to have his arm broken, necessitating it being kept bandaged up and in a sling for six weeks or two months, at the end of that period, the muscles would be mere ghosts of their former selves, and could no longer wield the hammer on the ringing anvil with the energy or regularity or precision that formerly won the admiration of the village youth. This is a mere instance of the general law that regular and appropriate exercise of a muscle, as indeed of any organ of the body, strengthens it and renders it more fit for the performance of its duties, while want of exercise or insuffıcent exercise is attended by gradual and increasing weakness, and if long enough persisted in, incapacity for duty.

The effects of Exercise upon the Heart and Circulation are well marked. The force of the heart's beat is increased and its frequency also. This effect is well known to all of us. When exercise is excessive it is usually the violence and speed of the heart's action or its irregularity that warn us we are overdoing our powers, and whenever we become aware of such unpleasant action we ought to accept it as a sufficient indication that the exercise should now cease. But the quickening of the heart and of the circulation caused by moderate and judicious effort ought only to be pleasant and exhilarating, and to this effect indeed is due much of the pleasure which appropriate exertion affords. The benefits of such quickening are shared by every organ of the body. The immediate result is, doubtless, to supply the active muscles with increased quantity of nutritive material, wherewith the increased chemical changes may be satisfied, but the indirect results are to stimulate the activity of other organs, lungs, liver, kidneys, skin, among the number, so that the whole body is awakened to more active life.

The effects of Exercise upon the Breathing are very important. There is an enormous difference between the amount of oxygen taken into the body during a period of rest and during a period of work, and also between the quantity of carbonic acid gas expelled during the same periods. Thus it has been found that a man at rest will absorb 417 grains of oxygen per hour, but during exercise 1829½, four and a half times the amount, and that during rest he will give out 603 grains of carbonic acid, but during exercise for a similar period 2501. Pettenkofer and Voit showed that during a day of work 2639 more grains of oxygen were absorbed and 4392 more grains of carbonic acid gas were given off than during a day of rest. At the same time there is increase in the quantity of watery vapour given off. This implies increased flow of blood through the lungs, more frequent expansion, and more complete expansion, of the lungs; it also implies greater activity of the muscles of the chest by which the movements of respiration are effected, and increased strength thereby. The value of such effects on the healthy condition of the lungs cannot be overrated. It has been strikingly shown that wind-instrument players, and those whose occupation implies regular and methodical expansion of the lungs, are singularly free from lung affections, and this can only be due to the bracing effect of the steady use of the organs. Whereas those who have little exercise seldom have the chest well expanded or the lungs well dilated, and the lessened vital changes implied must as surely weaken the lungs, as little exercise of the arm will be followed by weak and ineffective muscles.

The effects of Exercise on the Digestive Organs are always beneficial, if the exercise is well-timed; and there are no organs which more speedily indicate the evil effects of too little. Exercise taken too soon after a meal, whatever form it may assume, is injurious, because it diverts the blood stream from the stomach and associated organs to the muscles, and slows or arrests the natural process. But exercise, taken some time after food, aids the process in its later stages, and promotes the absorption of the nutritive portion of the food, by the quickening of the circulation, as well as by the effect of the increased movements of the diaphragm, due to the increased rate of breathing, and by other movements to which the intestine is subject. The activity of the liver is notably affected in a double way. It is stimulated by the frequent concussions that result from the bodily activity, and the increased consumption of the energy-yielding foods, fats, sugars, and starches, removes from it materials which, but for the call upon them, would be stored up in the liver for future use. Sluggish liver is one of the most immediate results of deficient exercise. It is a familiar fact that constipation of the bowels is almost certain to arise when exercise is not engaged in, and, in consequence, all the abdominal organs become loaded, and a sense of languor, of easy fatigue, a tendency to headache, and a feeling of general indisposition to exertion speedily result.

Exercise also influences the Kidneys and Skin. This it does not only by the increased flow of blood through them, but also by the increased demand made upon them to remove the waste which the exercise has caused. The quantity of water removed by the skin during exercise may amount to several pounds weight. The effect of exercise will not only be to cause the removal of waste products, the result of exertion, but also the removal of waste which might otherwise have remained, useless material burdening the bodily organs, but for this stimulus to their removal.

Of the influence of Exercise on the Nervous System Dr. Crichton Browne speaks strongly and with the voice of authority. He argues from the fact that the stimulus to muscular contraction is conveyed by motor nerves, the stimulus, in the case of voluntary movement, originating in a certain region of the brain, called the motor area, whose business it is to preside over muscular movements, and from the fact that the muscular movement stimulates sensory nerves, which convey the impression made upon them to other centres in the brain. The exercise of the muscles means, consequently, the exercise of nerves, of nerve-centres also, of part of the brain itself. The training by which a child acquires the ability to perform certain movements with rapidity, regularity, energy, and precision, is a training not of muscles only but of nerve-centres also, of the nerve-centres set apart to reign over these special muscles. The actions which stimulate the growth and development of certain muscles stimulate also the growth and development of certain associated parts of the nervous system. Just as a muscle or group of muscles will show weakness and also wasting if the movements, for whose performance they are designed, are not practised, so also will the associated nerve-centres fail to develop or waste—atrophy—for want of exercise of their corresponding muscles. Children can with ease acquire dexterity in the performance of certain movements, as for instance those of the fingers in the playing of a musical instrument, which can only with difficulty be learned in mature life and then never thoroughly, chiefly because in the mature years the nerve-centres, whose business it would have been to preside over the movements, are no longer capable of full development, because of prolonged neglect. "For the hand-controlling centre, if not fully exercised at its nascent (growing) period, can never afterwards attain to the highest cunning; witness the clumsy caligraphy of those who learn to write in mature life, even when they practise with more than boyish assiduity, and the inferiority of the work of any craftsman who has not served a regular apprenticeship to his trade." "A large district of the brain is made up, as we have seen, of motor centres, and is concerned in motor ideas, which form a no less essential part of our mental stores than sensory ideas. The growth of that district of brain is evidently to some extent dependent on muscular exercise, and if that is withheld at the growth period the development of that district is arrested. And not only so, but that district is made up of a series of centres in relation with different groups of muscles, and each centre is dependent for its development upon the activity of its own group of muscles, and the defective exercise of any group of muscles during the growth period in its own particular centre will result in dwarfing of that centre and a corresponding hiatus, or a general weakness must exist in the whole mental fabric. From this we might deduce that swaddling-bands so applied at birth as to restrain all muscular movements, and kept up during infancy and childhood, would result in idiocy—a speculation to which the wretched muscular development of most idiots and imbeciles, and the fact that their mental training is most successfully begun and carried on through muscular lessons, give some countenance. We should also have to infer that, in order to build up a sound and vigorous brain, we must ensure free exercise to the different groups of muscles in the order of the development of their centres, and must in no degree interfere with the natural sequence of their evolution." Thus exercise, "besides being essential to the maintenance of nerve-centres in health, has very special relations to their development and growth," and so it may be made to contribute to brain growth, and to the symmetrical development of the mental faculties. "We thus see that an extensive region of the brain, in which the motor centres are situated, and which is of course in intimate communication with all the other regions of the brain, can only be fully vigorous when the whole muscular system is fully vigorous also; and we recognize that good muscle work is essential to good brain work."

In the sentences that have been quoted, Sir J. Crichton Browne is speaking of the relation between the stimulus to growth of muscles and stimulus to growth of the nervous system in the period of youth, when growth is possible. But this does not imply that good muscular work is possible alongside of good brain work at the period of maturity. Rather the reverse is the case. Good brain work implies active and increased circulation of blood through the brain, even as good muscle work requires increased flow of blood to the active muscles. As the quantity of blood in the body is limited, the blood cannot supply the muscles in increased quantity and also the brain at the same time. Within certain limits exercise, implying quickened circulation, will stimulate the nervous system as well as the muscular, but the limits are narrow. Thus many a man, concentrating his thoughts on some subject, and finding his train of ideas somewhat slow of motion, forsakes his desk and paces up and down his room, finding in the stimulus of movement quickened thought. But in such mild exercise his brain gets a larger share of the increased flow of blood than his muscles. It is a different thing when a person really exerts himself, really causes his muscles to engage in active vigorous work, for then the determination of blood to the muscles diminishes the supply to the central nervous organs. Thus two men, walking along a road together, engaged in conversation, indicate by the speed of their movement the earnestness or profundity of their talk. If the conversation is really engrossing their thoughts, if their arguments are becoming closely reasoned, if they are keenly discussing a question with one another, the chances are that their movement is suggestive of aimlessness and uncertainty, halts are frequent, and more and more prolonged, till at the crisis of the discussion, both halt and stand face to face to argue the thing out. On the other hand, if the two are walking against time, with the desire of covering a certain amount of ground in a given time, it is the conversation that becomes halting and soon ceases, only an occasional word passing between the two. How common is it for men, who cannot get to sleep because the brain, pushed to its utmost activity by the demands of business or of professional work, will not quiet down or stop its turmoil of speculation, or calculation, or imagination, how common is it for men in such circumstances to get out of bed and pace the floor, or dress and go out for a steady walk of a mile or two, till the blood is brought down from the head to supply the active muscles, and the nerve-cells cease from troubling. Energetic muscular effort is opposed, that is to say, to vigorous mental work *carried on at the same time*, except that amount of brain effort that is necessarily associated with the muscular activity, the effort of will and so on. This is well proved by the mental state of those who give themselves up, more or less exclusively to muscular work, to athletic exercises, &c. The habitual use of the muscles to an excessive degree "tends to starve the brain" as Dr. Browne puts it, "or some portions of it by detaining large quantities of blood in the muscles to the detriment of the brain, and by limiting cerebral activity to certain tracts, and leaving other tracts wholly uncultivated. Professional athletes, and men entirely given up to sports of any kind implying great muscular effort, are generally dull and stupid; and a distressing hebetude creeps over boys who are permitted to neglect school work and concentrate their energies in gymnastics." At the same time, when there is no excessive devotion to the muscular effort to the neglect of the mental exercise, but when both organs get their due share of attention and their due call to activity, there is no manner of doubt of the benefits which the brain, in common with other organs of the body, derives from the muscular activity.

Moreover, it has been pointed out that systematic muscular exercise, by the effort of will which it implies, the training which accompanies it more or less, and the definite ends which are set up for effort and attainment, have an important bearing on character through their influence on the nervous system. "A consciousness of increased power is acquired, and this in turn begets self-confidence, resolution, and courage—qualities which, if rightly directed by proper moral and intellectual training, elevate the tone of the entire character, and aid to an important degree in subduing the passions. Indeed, the more perfect control which the mind possesses over a vigorous than over a morbidly sensitive body is a matter of everyday observation, and has given rise to Rousseau's seeming paradox "the weaker the body the more it commands; the stronger it is the more it obeys."

Exercise then is not a mere matter of muscle. It is not a mere question of firm energetic muscles against small flabby ones: it is a matter affecting the whole being, body and mind. It is a question of the vigour of the whole man, concerning the general well-being of the whole body, not an activity suitable for boys and young men, but necessary for both sexes and at all ages, a potent, nay an absolutely indispensable agent in the growth and development of the child, and as necessary for the continued health and active life of the fully grown as are food and air.

Excessive and Defective Exercise.

Excessive Exercise.—The benefits which have been described as resulting from exercise are so great that one is apt to think one cannot have too much of it. This is, of course, a mistake. The occurrence of fatigue is the immediate effect and indication of over-exertion, though one only of temporary occurrence. It implies that waste has been occurring with greater rapidity than its repair admits of, and that is not a normal occurrence of healthy activity. The heart experiences, in healthy states, no fatigue, because its periods of rest and of activity are so rhythmically alternated, and in such due proportion, that the upbuilding of the wasted tissue and the removal of the products of waste keep pace with the process by which the waste is produced. It appears that fatigue is due mainly to the accumulation in the muscle of waste products, and is also a sensation due to exhaustion of the nerve-centres, from which the stimulation to muscular contraction proceeded. Other temporary effects of excessive exercise are muscular pains, tremblings, cramp, &c., which rest speedily removes, and whose removal may be much aided by gentle friction with the dry hand and by the hot bath. But other and more or less permanent effects may arise from excessive exercise, which it is necessary specially to note. Changes of a degenerative kind may arise in the muscles concerned, and this is specially the case when the exercise affects small muscles or small groups of muscles. Thus writer's cramp, pianist's cramp, are illustrations, and similar illustrations are afforded by telegraph operators, violinists, type-setters, and others. A most instructive form is that known as Hammer Palsy, to which pen-blade forgers are liable. The explanation, as given by Dr. F. Smith, who has studied this form of paralysis specially, is as follows:—"The pen-blade forger uses a hammer about three pounds in weight. A pen-blade receives, in the process of forging and joining to the piece of iron by which it is attached to the haft, on an average, one hundred blows. The forger, if an industrious man, anxious perhaps to save, by working overtime, enough money to join a building society or to commence business on his own account, will work twelve or thirteen hours in a day. He will make as many as twenty-four dozen blades in a day, and in so doing will deliver twenty-eight thousand eight hundred (28,800) accurate strokes. The rapidity and accuracy with which these blows rain upon the slender piece of iron are wonderful to the onlooker. Supposing him to work three hundred days in the year, and to continue this for ten years, he will in that period have delivered eighty-eight million four hundred thousand (88,400,000) strokes, and just so many discharges of nerve force will have occurred in the motor ganglia which are engaged in the action, and in the higher ganglia which calculate the distance and judge of the amount of force necessary to be used." The paralysis that ensues affects specially the right hand.

There are, however, injurious effects produced by excessive exercise not limited to small numbers of muscles. Excessive exercise, as indicated in the paragraph relating to the effects of exercise on the nervous system, develops the muscular system to the detriment of the central nervous system. Apart from this negative result, positive evils arise, specially affecting the heart, lungs, and blood-vessels. If there is habitually excess of muscular activity, the constant state of increased activity to which the heart is stimulated leads to an overgrowth of the muscular tissue of the organ—to hypertrophy; and this produces an uncomfortable sense of the heart's beat, which, as a rule, ought to occur without much consciousness of it. One has the feeling of the heart thumping against the ribs, a feeling of which one is most readily conscious when one retires to bed, and which sometimes hinders sleep, and a feeling apt to be excited whenever anything occurs to worry or harrass one. Such a feeling may be sometimes due to mere irritability of the heart without any actual overgrowth. Another effect apt to be produced is that of dilatation of the heart—the walls of the heart yield to the excessive pressure of blood within them, and once any yielding has occurred it is more likely to proceed. The dilatation may be accompanied by overgrowth of a compensatory kind, so that the heart becomes greatly enlarged. Such a result is most likely to arise when the exercise necessitates severe strains being suddenly thrown upon the heart. Thus if a person tries to lift a very heavy weight, he takes a very deep breath, then fixes the muscles of the abdomen and the diaphragm, and, holding his breath, puts out all his strength. The pressure this produces upon the heart by the way in which the blood is detained in it is very great. Such a strain is always thrown on the heart in long diving, in lifting or hurling heavy weights, in taking long or high jumps and so on. The pressure thrown upon the lungs by the deep breath and the holding of it is also very likely to cause stretching of the walls of the air-cells, and ultimately a loss of elasticity of the lung tissue, so that the walls do not return to their usual state, and what is called emphysema (p. 283) occurs, just as an overblown india-rubber balloon will have a permanent bulge in some part of its wall. Besides these results, the blood-vessels may suffer by the excessive pressure of the blood within them. Rupture of a vessel or bleeding may occur, or a crack of the inner wall of one of the larger blood-vessels or a bulge of part of the wall may be the beginning of aneurism.

Excessive exercise of groups of large muscles is likely to end in the production of disproportion and deformity, as in the unequal shoulders of the horseman, because of the special development of the rein-holding limb, or the lob-sidedness of the schoolboy who always carries his books on one side.

It is to be noted that so far as these results occur in those fond of running, jumping, rowing, diving, &c., they are the consequences of bad regulation of the exercise, are very often doubtless the result of strain without previous training or preparation. The evil effects of sudden strain on lungs or heart, quite unused to it, are clearly revealed in the cases of men beyond middle life, after a quick run for a car or a hurry for a train. In them not infrequently the heart refuses the effort, and collapse is the result. The effects of too much exercise are usually seen in young men and men in the prime of life, who are fond of athletic sports, and are keen at competitions. It is in these cases that the desire to excel needs restraint and the firm guidance of some one experienced in training. In young children effects of excess are not seen. They follow their instincts and rest when fatigue threatens, not pushing their efforts beyond a safe limit. Boys and girls about the age of puberty (p. 472), however, need careful restraint.

Defective Exercise.—The evils of insufficient exercise are more numerous than those of excess. The youth who has never had sufficient exercise never attains to fulness of growth and development. He remains stunted, soft, and puny, wanting in vigorous circulation, and the ruddy glow of health. He is unfit for prolonged effort at work or play. Weak-chested as well as weak-limbed, nervous and awkward, he is defective in nervous as well as in muscular activity; and good mental as well as good muscular work is impossible to him. Imperfect general nutrition and bad digestion are his portion. Girls suffer most frequently from such conditions, because healthy natural movement is too commonly denied them. In them bad development of the figure, lateral curvature of the spine, popularly called "growing out of the shoulder" is a frequent result. In adults a falling-off of general health and vigour, an unhealthy deposit of fat, weakened heart and circulation, are results to be expected. The children of such parents inherit feeble constitutions, and one generation passes on the inheritance to another, producing a puny race unable to withstand the strain and pressure of life.

It is now time to consider briefly the various forms in which exercise can be taken and the advantages of each, as well as any special rules applicable to each kind.

Various Forms of Exercise.

Walking.—There is no form of muscular activity which brings into full play all the benefits to the body that exercise can confer like that of walking. It calls into play the greatest number of muscles, leaving none outside the range of its influence we may say, except those of the upper extremities. The action of the muscles appropriate to it is regular and methodical, not sudden nor spasmodic. It implies no undue strain upon any organ, supposing of course that it is not unduly prolonged; and it is suited to all ages, except, of course, the very youngest. At the outset the muscles of the trunk are concerned in the maintenance of the erect posture; and the swaying movements of the body, produced by the weight of the body being carried now by one leg now by the other, imply the harmonious co-operation of many muscles to prevent overbalancing. All the muscles of the lower limbs, those from the hip to the trunk, those which straighten the leg and those which bend it, the muscles moving the ankle-joint and those acting on the toes, all have their regular alternation of contraction and of relaxation, as the body is pushed forward, as the weight is gradually moved from the right leg to the left, as the body gets the final push from the right leg acting through the ball of the toes, as the right leg is raised and swung forwards, pendulum-like, while the left leg kept straight now alone supports the weight, and so on. One group of muscles contracts after another in rhythmical fashion with each stage in the forward movement, while others imperceptibly and yet effectually maintain the balance. The muscles of the head and neck, of the chest and abdomen all have their share, great or small, in the ordered movement. Now this movement so apparently simple and easy is exceedingly complicated, and implies the expenditure of a very large amount of energy. The Rev. Professor Haughton, M.D., calculates that a man walking along a level road at a rate of about three miles an hour expends an amount of energy which would raise a weight equal to $\frac{1}{20}$ that of his body through a height equal to the distance walked. Thus a man who in his clothes weighs 150 lbs. walks, let us say, one mile. A mile is 1760 yards or 5280 feet. The $\frac{1}{20}$ of 150 is 7$\frac{1}{2}$ lbs. He expends therefore energy equal to that needful to lift a weight of 7$\frac{1}{2}$ lbs. 5250 feet into the air, or 1 foot 39,375 feet, that is 39,375 foot-pounds, or 17$\frac{1}{2}$ foot-tons in round numbers (17·67 exactly).

Thus a man 150 lbs. in weight walking	1 mile	expends energy which would lift	17$\frac{7}{10}$	tons one foot high.
,, ,, ,,	2 miles	,, ,, ,,	35$\frac{1}{3}$	,, ,,
,, ,, ,,	5 ,,	,, ,, ,,	88	,, ,,
,, ,, ,,	10 ,,	,, ,, ,,	176$\frac{7}{10}$	,, ,,
,, ,, ,,	20 ,,	,, ,, ,,	353$\frac{4}{10}$	,, ,,

If the man carries a weight—a parcel, an umbrella, a bag—this ought to be taken into account. If he carries an overcoat, whether over his arm or on his back, it ought also to be counted. If his overcoat weighs 5 lbs. this extra weight means the expenditure during every mile of a quantity of energy sufficient to raise nearly $\frac{3}{5}$ths of a ton 1 foot, and in the 20-mile walk amounts to nearly 12 foot-tons. But this is the calculation only for a level road. If at the end of his mile he has ascended 50 feet, this would need to be added to the number of foot-pounds in calculating the energy. He has raised his body (150 lbs.) this height, however gradual the ascent may have been, and 7500 foot-pounds or 3$\frac{1}{3}$ foot-tons would need to be added. Now, according to Dr. Parkes, 300 foot-tons is an average day's work for a strong healthy adult. We can, therefore, calculate what number of miles walked along a level road will be equal to a good day's work. A 20-mile daily walk would, therefore, be above the average. According to Parkes "an amount of work equal to 500 tons lifted a foot is an extremely hard day's work, which perhaps few men could continue to do. Four hundred tons lifted a foot is a hard day's work. Now, according to the table 353·4 foot-tons is the work done in a 20-mile walk, so that 300 foot-tons would be almost exactly 17 miles. This walk is then a fair day's work on a level road. There are conspicuous illustrations of this amount of work in walking being enormously overdone, but for only limited periods. Thus the amount of work done by Weston in his six-days' walking match has been calculated. On the first day no less than 1525·3 foot-tons were performed, that is, energy was expended in walking sufficient to raise 1525·3 tons one foot high; and on the sixth day the work done equalled 967$\frac{1}{2}$ foot-tons. The total amount of work done in the six days was equal to 7026 foot-tons, making a daily average of 1171 foot-tons. De Chaumont mentions an illustration of a European weighing 160 lbs. walking 73 miles, which would equal 1378 foot-tons, but it was done in about 17 hours, and thus became really equal to about 2400 foot-tons. For the speed with which the work is done affects the result, or, as de Chaumont puts it, "there is a velocity at which the maximum amount of work can be done at the minimum of expenditure." This, I believe, is also true in the case of a steam-engine. A steam-vessel may be built with engines fitted to take her at a moderate rate of speed, say 11 or 12 miles an hour, at a certain cost, but if she is wanted to go much faster, say 20 miles an hour, the cost increases out of all proportion to the increase of speed, so that in the steam-engine there is also a velocity at which a maximum of work can be done at a minimum of cost. In walking the economical rate is three miles an hour. This is the rate into which one naturally drops, when adopting a comfortable easy gait, and it is the ordinary rate of the soldier's march.

These calculations have been made on the assumption that the work is done under favourable circumstances, that there is, for example, absence of all restraint from the muscles, so that they have full freedom to go through their movements in a way natural to them. This implies appropriate dress. If owing to the wearing of a long overcoat, for example, the natural movements of the legs have been restrained, the same distance covered in the same time would imply the expenditure of a large amount of more energy.

Any restriction of the breathing is specially disadvantageous in walking. The increased need of oxygen, which the continually increased expenditure of energy implies, means quickened breathing, and any garment so made, or so tightly worn, that free play to the chest is not permitted, will seriously inconvenience the walker. All these disadvantages are seen to the full in women's dress as a rule, the long skirts, the tight corsets preventing free movement of the lower ribs, and the close neckerchiefs, all being opposed to the free play of muscles that is desirable. In men tightly-buttoned close-fitting coats and high collars are also undesirable. Then, further, if each individual is to be permitted to expend his energy in a manner most economical his walk must be one suited to himself; the length of his step must be fitted to his length of limb; and his attitude must be the one which is least irksome to him, and which restrains him least. Thus a tall man and a short man, walking together at the same speed over the same ground and keeping step, do not spend the same energy in the walk. We shall suppose that the tall man is thinner than the short one, and that in spite of their different heights the two are the same weight. If the short man tries to suit his step to the tall man's he expends a great deal more energy than is needful, and if the tall man restrains his movements to suit his companion he also is not economical of energy. The two should walk along each suiting himself, so that the tall man's steps will likely be longer but fewer than his companion's. This illustrates one of the difficulties of the soldier's march, in which all have to keep together. The restraint implied not only by this necessity, but by the stiff attitude, &c., leads to the march being slower, and makes the impossibility of covering more than 10 to 15 miles per day, unless for a brief period and with the troops lightly equipped.

If, again, owing to the form of the boots, the natural elasticity of the step were destroyed, the work would be more laboriously performed, or if owing to projecting toes, the foot has to be raised to a greater height, at each step, to keep it from scraping the ground. If the heel of the boot is too high or too low, an unnecessary strain is thrown upon the muscles, in the first case to keep the body from being overbalanced forwards, and in the second case the calf muscles are unduly taxed in lifting the heel and throwing the weight of the body forward from one leg to the other. A double-soled boot should have a heel an inch deep, and a single-soled boot a heel just over ½ inch deep. The boots should be wide-soled, the soles projecting beyond the "uppers," when the weight of the body is borne by them.

Then, as has been indicated, ascending a hill implies a great increase in the expenditure of energy, for one must consider that the total weight of the body is raised. How great the expenditure may be for an apparently little height is shown by the following table, which indicates the expenditure of energy by a person weighing 150 pounds mounting a stair, every step of which is 6 inches high:

A person 150 lbs.	in	mounting	1 step	expends energy equal to	75 foot-pounds.
,,	,,	,,	5 steps	,, ,,	375 ,,
,,	,,	,,	6 ,,	,, ,,	450 ,,
,,	,,	,,	10 ,,	,, ,,	750 ,,
,,	,,	,,	12 ,,	,, ,,	900 ,,
,,	,,	,,	20 ,,	,, ,,	1500 ,,
,,	,,	,,	30 ,,	,, ,,	2250 ,,

This last is equal to a little over 1 foot-ton (=2240 foot-pounds), and is equal to the body raised only 15 feet. Supposing this stair to be ascended 10 times a-day, the energy expended, merely in the ascent, would thus be equal to raise over 10 tons 1 foot high, and if the stair were ascended 17 times the energy expended would have been sufficient for a walk of one mile. The number of steps this implies is only 510 of 6 inches each. But there are 2100 walking steps in a mile, assuming each step to be the regulation military step, namely 30 inches, so that each step, in ascending a stair where the steps are 6 inches high, requires the expenditure of as much energy as $4\frac{1}{10}$ steps of the regulation length on a level road. That is to say it requires the same amount of energy to lift one's body 6 inches high in the air as to carry one's body 123 inches along a level road by walking, that is $10\frac{1}{3}$ feet. That is to say the expenditure of energy that will raise the body a direct height of 12 inches, that is 1 foot, will carry the body by walking $20\frac{1}{6}$ feet, or, in other words, a climb of 1 mile means the expenditure of as much energy as a 20-mile walk on a level road.

It is, therefore, plain how persons able to walk only short distances, slowly and with great effort, become at once aware of the slightest rise in the ground. The sudden need of a much greater expenditure of energy tells at once on the heart and the breathing, and the person is quickly brought to a standstill.

The various considerations that have been stated enable one to form a rough estimate of the daily amount of walking exercise each one should engage in. Take the case of the business man, who takes the omnibus or car to his place of business, spends the most of his day at his desk and returns home in the evening, little disposed to move out again in the evening. In the case of the young man, his pallor, bad digestion, headaches, and general languor and feebleness may be the results of the little exercise, in the case of the middle-aged man, perhaps it is increasing stoutness, breathlessness, rheumatic or gouty tendencies that warn of the need of muscle work and fresh air. Both are ordered more exercise, but of what kind and how much, both are commonly left in doubt. On this point Dr. Parkes says, "we can perhaps say, as an approximation, that every healthy man ought, if possible, to take a daily amount of exercise in some way, which shall not be less than 150 tons lifted 1 foot. This amount is equivalent to a walk of about nine miles; but then, as there is much exertion taken in the ordinary business of life, this amount may be in many cases reduced. It is not possible to lay down rules to meet all cases; but probably every man with the above facts before him could fix the amount necessary for himself with tolerable accuracy."

As regards women a daily expenditure of energy to the amount stated could not be borne by them. That the habit of daily exercise is one of which they stand in most urgent need is not gainsaid by anyone. A man's business, as a rule, takes him out of door, and if the risk of his taking too little exercise for health is great, how much greater is it in the case of women, whose duties as a rule keep them indoors? Thus it is that for days together many of them are not outside at all; then they sally forth on a shopping expedition, spend many hours lingering about shop windows and hanging over shop counters, and then return home fatigued to the uttermost, requiring several more days at home before a further expedition is ventured on. This is a most injurious system, not only because of the many days without out-of-door exercise, but also because of the sudden exertion put forth for which the body is unfitted. Of course in attending to their household duties, they have exercise, but exercise wanting the freshening and invigorating influence of exercise in the open air. It is because of the warmer air of the house, and because of its deficiency in oxygen, that this kind of exercise is uniformly tiring and never invigorating. A daily walk, amounting altogether to four miles, ought to be insisted on, and would materially conduce to the health and comfort and liveliness of the women of the household.

Concerning children not much need be said. If they are left to their healthy instincts no artificial standards need be applied, or artificial methods used. For them no exercise can take the place of the play in which they naturally indulge, by which one may say every muscle and every sense are exercised in due amount. No school system of exercise can take the place of the exercise which they will themselves take, if they are allowed freedom of healthy activity. The decorous walk cannot meet their natural instincts. It is a false system of education which ignores this fact, and which seeks to force young children to repress their natural tendencies to romp by imposing a standard of manners and a sedateness of behaviour suitable enough, may be, for their elders, making up for it by some gymnastic device or "calisthenic exercises." For children let particular care be taken that their dress is not inconsistent with their natural freedom of movement. Too often a desire to have their children dressed according to the current fashion makes parents "impose a style of dress which forbids healthful activity. To please the eye, colours and fabrics are chosen totally unfit to bear that rough usage which unrestrained play involves; and then to prevent damage the unrestrained play is interdicted. 'Get up this moment; you will soil your clean frock,' is the mandate issued to some urchin creeping about on the floor. 'Come back; you will dirty your stockings,' calls out the governess to one of her charges, who has left the foot-path to scramble up a bank. Thus is the evil doubled. That they may come up to their mamma's standard of prettiness, and be admired by her visitors, children must have habiliments deficient in quantity and unfit in texture; and that these easily-damaged habiliments may be kept clean and uninjured, the restless activity so natural and needful for the young is restrained. The exercise which becomes doubly requisite when the clothing is insufficient, is cut short, lest it should deface the clothing. Would that the terrible cruelty of this system could be seen by those who maintain it! We do not hesitate to say that, through enfeebled health, defective energies, and consequent non-success in life, thousands are annually doomed to unhappiness by this unscrupulous regard for appearances; even when they are not by early death literally sacrificed to the Moloch of maternal vanity."

I have quoted these remarks of Herbert Spencer regarding the exercise that ought to be freely permitted to the young of both sexes, and I cannot do better than also transcribe what he has said regarding the physical education of girls. "To the importance of bodily exercise," he says, "most people are in some degree awake . . . at any rate, in so far as boys are concerned. . . . Unfortunately the fact is quite otherwise with girls. . . . Why this astonishing difference? Is it that the constitution of a girl differs so entirely from that of a boy as not to need these active exercises? Is it that a girl has none of the promptings to vociferous play by which boys are impelled? Or is it that, while in boys these promptings are to be regarded as stimuli to a bodily activity without which there cannot be adequate development, to their sisters, nature has given them for no purpose whatever—unless it be for the vexation of schoolmistresses. Perhaps, however, we mistake the aim of those who train the gentler sex. We have a vague suspicion that to produce a robust physique is thought undesirable; that rude health and abundant vigour are considered somewhat plebeian; that a certain delicacy, a strength not competent to more than a mile or two's walk, an appetite fastidious and easily satisfied, joined with that timidity which commonly accompanies feebleness, are held more ladylike. We do not expect that any would distinctly avow this; but we fancy the governess-mind is haunted by an ideal young lady bearing not a little resemblance to this type. If so, it must be admitted that the established system is admirably calculated to realize this ideal. But to suppose that such is the ideal of the opposite sex is a profound mistake. That men are not commonly drawn towards masculine women, is doubtless true. That such relative weakness as asks the protection of superior strength is an element of attraction, we quite admit. But the difference thus responded to by the feelings of men, is the natural, pre-established difference, which will assert itself without artificial appliances. And when, by artificial appliances, the degree of this difference is increased, it becomes an element of repulsion, rather than of attraction.

"'Then girls should be allowed to run wild—to become as rude as boys, and grow up into romps and hoydens!' exclaims some defender of the proprieties. This, we presume, is the ever-present dread of schoolmistresses. It appears, on inquiry, that at 'Establishments for Young Ladies' noisy play like that daily indulged in by boys is a punishable offence; and we infer that it is forbidden lest unladylike habits should be formed. The fear is quite groundless, however. For if the sportive activity allowed to boys does not prevent them growing up into gentlemen; why should a like sportive activity prevent girls from growing up into ladies? Rough as may have been their playground frolics, youths who have left school do not indulge in leap-frog in the street, or marbles in the drawing-room. Abandoning their jackets, they abandon at the same time boyish games; and display an anxiety—often a ludicrous anxiety—to avoid whatever is not manly. If now, on arriving at the due age, this feeling of masculine dignity puts so efficient a restraint on the sports of boyhood, will not the feeling of feminine modesty, gradually strengthening as maturity is approached, put an efficient restraint on the like sports of girlhood? Have not women even a greater regard for appearances than men? and will there not consequently arise in them even a stronger check to whatever is rough or boisterous? How absurd is the supposition that the womanly instincts would not assert themselves but for the rigorous discipline of schoolmistresses!

"In this, as in other cases, to remedy the evils of one artificiality, another artificiality has been introduced. The natural, spontaneous exercise having been forbidden, and the bad consequences of no exercise having become conspicuous, there has been adopted a system of factitious exercise—gymnastics. That this is better than nothing we admit; but that it is an adequate substitute for play we deny. The defects are both positive and negative. In the first place, these formal muscular motions, necessarily less varied than those accompanying juvenile sports, do not secure so equable a distribution of action to all parts of the body; whence it results that the exertion, falling on special parts, produces fatigue sooner than it would else have done: to which, in passing, let us add, that, if constantly repeated, this exertion of special parts leads to a disproportionate development. Again the quantity of exercise thus taken will be deficient, not only in consequence of uneven distribution, but there will be a further deficiency in consequence of lack of interest. Even when not made repulsive, as they sometimes are, by assuming the shape of appointed lessons, these monotonous movements are sure to become wearisome from the absence of amusement. Competition, it is true, serves as a stimulus; but it is not a lasting stimulus, like that enjoyment which accompanies varied play. The weightiest objection, however, still remains. Besides being inferior in respect of the *quantity* of muscular exertion which they secure, gymnastics are still more inferior in respect of the *quality*. This comparative want of enjoyment which we have named as a cause of early desistance from artificial exercises, is also a cause of inferiority in the effects they produce on the system. The common assumption that, so long as the amount of bodily action is the same, it matters not whether it be pleasurable or otherwise, is a grave mistake. An agreeable mental excitement has a highly invigorating influence. . . . Granting then, as we do, that formal exercises of the limbs are better than nothing—granting, further, that they may be used with advantage as supplementary aids, we yet contend that they can never serve in place of the exercises prompted by nature. For girls, as well as boys, the sportive activities, to which the instincts impel, are essential to bodily welfare. Whoever forbids them, forbids the divinely-appointed means to physical development."

Running is a form of exercise indulged in without harm by healthy children of both sexes, and useful for growth of muscles, expansion of the lungs, and stimulation to the heart. It is not, however, desirable at the period of most rapid growth, when boys are passing into manhood and girls into womanhood. When this period is passed in boys, is the time for training for running, namely between the years of twenty and thirty. After thirty running, especially in races, is not advised. The rate of expenditure of energy is in running enormously increased. The length of step is usually not much increased; it is the rapidity of the step that is affected. Thus in soldiers the number of steps per minute at "quick march" is 116, and at "the double" 166, the length of step being increased only from 30 to 33 inches, so that the distance covered rises from 187 feet per minute to 453, the latter being equal to a little over a mile in 11 minutes. It is this fact that makes the short man excel in short races, and the tall man in long-distance races. For the latter can increase his steps to a greater number per minute more easily, provided his utmost speed does not need to be very long maintained, while the tall man's most convenient pace will enable him to cover a longer distance at a good speed.

Training suited for such exercise is given, as follows, by Maclaren in his book on training: "With a man unaccustomed to running, I would say, let him begin with a mile; setting himself to cover the distance in about eight or nine minutes, at the easiest pace and make-believe race he can run in. Let him break from his walk to the ground into an easy trot, and practise it until he find his wind decidedly improved, and the work, such as it is, pleasurable. He may then do one of two things—either increase the distance by another half-mile, to be run at the same pace, or hold to the same course and cover the distance in one or two minutes less. When the mile can be run in six minutes as easily as it was run in eight, let the tactics be changed; let him break the uniformity of the run, and cultivate variety of pace; let him begin the race, as at first, at an easy trot; keep at it for a quarter of the distance to allow the organs of respiration and circulation to take up gradually the accelerated action which is demanded of them as soon as the trotting begins, allowing the muscles employed in locomotion to take up their accelerated action when the walking is relinquished; let the second quarter be in the same style, but at a somewhat quickened pace, still keeping within the margin of easy performance; and let the third, if the preceding causes no distress, be quicker still, gradually culminating towards its close to an effort at the utmost strain of the powers; and last, let it subside in the fourth quarter gradually into the first easy trot, ending in the effortless walk, to allow the throb of the heart and swell of the arteries and veins to subside and settle down, and the lungs to resume their peaceful tidal motion, and the air current in their cells its rhythmical ebb and flow. I do not give these as absolute, but as approximate distances and rates of speed; they must be in all cases proportioned to the powers of the individual; but whatever may be his powers, let him begin within them, and augment the work, very gradually, whether in velocity or distance; and this augmentation should always be regulated by the actual advancement made by the running powers, until at speed and without preliminary breath or preparation the distance prescribed can be run. The distressing and often incapacitating pain of shin-ache is owing entirely to a disregard of this principle of gradual preparation. It is but the same kind of discomfort, arising from the same cause, which men out of practice feel in the arms on rowing suddenly at speed; that is, unpreparedness in the parts to perform the work suddenly put upon them." Diet suited for such training has already been indicated on p. 621.

Jumping implies a sudden great expenditure of energy. Thus it is calculated that a jump 2 feet high, made by a man weighing 154 lbs., is equal to an expenditure of energy which would raise 308 lbs. 1 foot high, and the highest jump on record 6 feet 2½ inches "is equivalent to the sudden raising of 956 lbs., or about ⅗ths of a ton, and hurling it into the air." The strain of such an effort falls on few muscles—those of the calf of the leg and front of the thigh. The great effort is sometimes not unattended by harm to the muscles involved or the bones to which they are attached. The muscles are sometimes torn across, and the bones may be snapped by the strong and sudden contraction of the muscles. The bones thus affected are usually the small bone of the foreleg—the fibula—and the patella or knee-pan, the latter of which is broken across by the pull of the straight muscle of the thigh—the rectus (see p. 74). Rupture may also be produced. Jumping of any extensive kind should not be engaged in without previous training, such as that for running, and the best age is said to be between the nineteenth and twenty-fifth years.

Riding is, next to walking, the most universally useful form of exercise. Pleasant to youth, it also has so much attraction for the elderly, that they enjoy the daily horse exercise when they could not be induced to walk. It is capable of so much modification, as regards the actual amount of effort put forth, that it may be suited to many for whom very active exercise is not desired. Thus though the horse may go at little more than a walking pace, and the rider may put forth practically no effort at all, yet he may be carried a considerable distance, so as to obtain to the full the exhilarating influence of fresh air without fatigue. Then even at such an easy gait, and with little exertion, the movements of the horse communicated to the rider produce very considerable stimulating effects upon the liver and other abdominal organs. It is, on this account, an invaluable form of exercise for men beyond the mid term of life, who lead sedentary lives, and who either will not or cannot put forth the energy, which a walk sufficient for purposes of health would imply. In the gentle canter they get the needed stimulus to the digestive organs without fatigue. It is this property of stimulating the abdominal organs by the rhythmical shocks, produced by the movement of riding, that makes exercise on horseback so peculiarly the kind of exercise for the dyspeptic. While thus capable of being made one of the gentlest kinds of exercise, it of course affords scope for much more vigorous effort. For women it is a very suitable kind of exercise, provided due discrimination be employed. Wherever the means of parents permit of it, children should be taught riding, although the daily riding lesson or canter ought never to be substituted for play or deemed sufficient exercise. Constant riding produces characteristic changes in certain parts of the body. Wasting of the muscles of the inner side of the thigh results from the continual over-exertion of these muscles in keeping the knees pressed against the horses' sides; and to this the awkward walking gait of ostlers is due. Then the marked disproportion in the use of the left hand and arm over the right, by holding the reins, occasions a prominence of the left shoulder particularly likely to be marked in girls and women. The remedy for these defects is to avoid making riding an exclusive form of exercise, and if children are allowed full scope for play and other forms of recreation, such as tennis, &c., they are not so likely to arise. It may be remarked that it is of very great importance to anyone who is to have frequent occasion to be on horseback that he should be suited to a horse. A short-limbed man on a broad-backed horse must suffer some distortion of the limbs, and if he is subject frequently to the improper position, it will undoubtedly leave its evidence permanently on the shape of his limbs. The reverse conditions would tend to make a man knock-kneed. "The men who show least deformity are those of a medium height, of about 5 feet 8 inches." The need of remembering this fact in the case of growing children, with their soft yielding bones, is apparent.

Rowing is, according to Maclaren, the chief of all our recreative exercises; no other can enter the lists against it. There is a difference, however, according to the same authority, between rowing as an exercise and rowing as an art for the object of sending a boat at the greatest speed through the water. In the latter case the boats are so constructed, they are so light, they offer so little resistance to the water, the "form" of stroke adopted is such, that "a boat-race has now become a matter of wind rather than of muscle," and, as an old waterman remarked to Maclaren at a university race, "The crew that can bucket it the fastest will win the race, *if they don't bu'st.*" Owing to the diminished resistance of the boat, way is not kept up unless by short quick strokes, implying great strain upon the heart and lungs rather than great muscular exertion, so that it has become a question of "wind" rather than of muscle. On this account modern alterations in the directions noted "have advanced rowing as an art, but detracted from it as an exercise." Regarding rowing as thus practised, Maclaren says, it gives "employment to a large portion of the back, more to the loins and hips, and most of all to the legs; but it gives little to the arms, and that chiefly to the forearm (because of the actions of grasping and feathering the oar), and least of all to the chest. Moreover, as there is but *one* movement in rowing, namely, the stroke, indefinitely repeated with the most rigid precision, and as it is in the rearward half of this movement only that any real muscular effort is made or resistance encountered, it follows that every muscle of the body not employed in this action is excluded from the exercise; moreover, also, every muscle included in it is employed in but one line of action, while it is qualified and designed to act in many, and will be developed and strengthened in proportion as these manifold modes of its use are observed; and moreover, again, as, with few exceptions, all muscles have antagonistic muscles, designed to perform counter movements, it follows that as rowing consists of but one motion, the antagonistic muscles of those employed in executing this motion must be virtually unemployed. Thus, as I have said, the legs have strong employment in rowing, but it is the *extensor* muscles alone which have actual employment; the *flexors* are comparatively idle; they perform no exercise, they gain no bulk, they obtain no increase in power. They are excluded from the work, they have no share in the reward. . . . The part of the body which receives the smallest share of the exercise in rowing is the chest; it has little or no employment in the muscular effort required for the propulsion of the boat; and this is impressively evident in the results. Not only does it make no advance in development in this exercise, but, if it be exclusively practised, an absolutely depressing effect is exercised." Maclaren goes on to say that this result of falling off in growth of certain parts of the body by exclusive devotion to one exercise is common to any single exercise, and that some complementary exercise is required for developing these parts so neglected. For rowing he thinks the added exercise should be one which, while giving work to the muscles not employed in rowing, will in particular develop the respiratory capacity, for in rowing "respiratory power makes the first claim, and makes it more exactingly than in any other mode of physical exertion in which men can be engaged, not only on account of the rapidity of the inspirations and expirations, and not only from the fact that they are *not* regulated by the natural action of the lungs themselves, but by the artificial movements of the exercise, but also from the interruptions caused by the fixing of the chest, and forcibly holding in the lungs of the air inspired after, in the natural order of the function, it would have been expelled." The best auxiliary exercise in the case of rowing he thinks is running, when engaged in in a regular methodical way, as indicated on p. 754.

In ordinary rowing, however, rowing for pleasure, the pastime so almost universally engaged in during summer holidays on river or lake or at the sea-coast, the circumstances are very different. The build of the boats is different, and in every way there is much more resistance to be overcome, and, therefore, much more muscular effort put forth. Moreover the effort is put forth in a different manner, for the long swing of the back is very different both in its effects upon the muscles, and in its effects upon the heart and lungs, from the quick high-pressure stroke of the racer. The steady swinging stroke of moderate length, kept up, say by four persons, in a four-oared boat, which carries other persons as well as provisions, let us suppose, for the party going for a picnic by water, implies chiefly muscular effort, and no special strain upon the respiratory organs. In such rowing many groups of muscles receive exercise. No muscles are more exercised than those of the back, and those passing between the trunk and the lower limbs, both in the backward swing and the forward movement. For keeping up such exercise for any length of time, it is necessary that the breathing be accelerated little above the ordinary rate. A stroke of 20 to 25 can be well maintained, and will give good speed.

It is, then, really the latter circumstances that one must consider most, and for which one may state a few of the accepted rules. First of all, the clothing should be loose, tight nowhere. Women should specially note this condition. Stays ought, for such exercise at least, be laid aside. With them neither the muscles of the back get full play, nor does the breathing. For girls whose back muscles have had little opportunity of development, no exercise could be more recommended, provided it be engaged in in a judicious way and not rushed at. The clothing should be of flannel material, and should be changed when the exercise is over. An extra coat or wrap of some kind should be at hand in the boat, to be put on if one stops rowing for a little. The breathing should not be restricted during the stroke; the breath should not be held, for that would imply holding the breath for a considerable time, then letting it go and taking in a new breath in a much shorter time than is usual. This implies a complete alteration in the natural rhythm of respiration, which leads to breathlessness and speedy fatigue. Indeed the quick onset of fatigue in the inexperienced rower is commonly, not the result of muscular effort, but the consequence of interference with breathing, and a deficiency of oxygen in the tissues. Let the breathing, then, be as natural as possible as to rhythm; accelerated slightly it will naturally be. Then the exercise is not to be engaged in without some regard for muscles unaccustomed to that form of activity. The youth whose only opportunity of such pastime is during the summer holiday, ought not to go at it his first day, as if he had been engaged in no other occupation all his life. Some restraint must be exercised; a little the first day at a quiet easy pace will prepare for a little more the second, and still more the third, till after several days more prolonged and vigorous effort may be indulged in with ease. The rower should stop whenever fatigue threatens; and he should never engage in the exertion till an hour or more after a full meal. Blisters are to be prevented by the handle of the oar being quite smooth, and being kept quite dry, by the hand being dry, sweat being removed (and to the same end dusting with white oxide of zinc powder is advised), and by never allowing the oar to slide in the hand, all "feathering" being executed from the wrist and elbow, chiefly from the wrist. If blisters threaten, "stop rowing for an hour, wash the hands well with soap and water, wipe the tender parts over with some vinegar, and then gently rub spirits of wine, or, if that is not available, whisky, gin, or brandy over the tender parts, drying the parts perfectly between each step of the process."

Lawn Tennis is one of the best of modern exercises, combining, as it does, an infinite variety of muscular effort, with a high degree of pleasurable excitement, and demanding and cultivating mental as well as physical alertness. It does not give mere exercise to the muscles, but it affords also a training in the art of constantly varying the quantity of energy expended to suit a particular purpose. It involves also some education in judging of distances, and the eyes receive no small part of the educational effect. One may say that it puts every muscle of the body into active exercise. Take the arm as an example; the muscles which bend as well as those which straighten it, the muscles which carry it away from the body, and those which carry it across the body, those which carry it high into the air, those which swing it backward and those which carry it forwards, are all in rapid succession called on for full activity. At one instant the forearm is rapidly twisted to deliver a backhanded blow, and at the next the action is as quickly reversed to take the return ball off the other side. Similarly every other part of the body has its work to do, as the player bends well forward to catch a low ball, now throws his body to one side now to the other, now bending well back, or jumping high in the air to stop a high ball, all the while his legs have to be on the alert to carry him wherever the vagaries of the game may demand his presence. It is a game in which anyone may take part, from the 8-year-old to his grandfather, a suitable partner only being necessary. It is a game in which women may hold their own with men, and meet them on nearly equal terms. Perhaps there is no game which will so rapidly impress women with the evils of fashionable dress.

No game involving vigorous exercise is without some kind of risk, and lawn tennis is no exception to the rule. The extreme rapidity and suddenness with which movements must be effected in every game, in which the players are even moderately expert, tend to produce sprains of tendons and tears of muscle. In particular, a tear of tendon or muscle is common in the neighbourhood of the elbow-joint, causing what is now called **tennis elbow**. It is either a tear of ligament over the head of the radius, the outer of the forearm bones, due to rapid turning of the hand palm-downwards, to deliver a backhanded stroke, or it is a tear of one of the muscles, by whose contraction the arm is recovered from this position. In each case the pain is below the elbow-joint on the outer side of the fore-arm. The treatment is complete rest from the game for the remainder of the season. The part should be gently rubbed upwards, and an elastic elbow-cap may be worn. Other muscles are apt to suffer in a similar way. The biceps is sometimes torn near its point of origin, at the inner and upper part of the arm (see Fig. 67, p. 72), at which place a swelling immediately appears, and the arm drops. Rupture of the tendo Achillis (p. 75) may also happen, though it is not common, consequent upon the taking of a sudden forcible spring. Rest and rubbing, rubbing of the massage type are the remedies.

Bicycling and Tricycling.—This is a form of exercise which has grown immensely in popular favour of recent years. At first sight the muscular effort involved in driving the bicycle might seem greater than that required for the tricycle, because with the former machine the action of a great many antagonistic muscles is involved in maintaining the balance, but in reality the work done in driving the latter is much greater. It is quite true that the beginner speedily experiences a sense of fatigue, not restricted to the lower limbs, but general to the whole body, due to the strain in attempting to keep his balance. This is, however, because he has not acquired the art of nicely adjusting the action of the various muscles for the desired result. It is a misuse of his muscular effort, just as the child learning to walk expends a great deal of effort uselessly. The person who has acquired the art of sitting his machine is hardly conscious of the action of the various muscles which maintain the balance. On the bicycle the weight of the rider is partly supported by the saddle, and is partly made most effective use of in driving by being borne in the treadles, supposing, that is, that the height of the wheel is properly suited to his length of limb. It is, therefore, the muscles of the legs that are specially exercised, and in particular the extensors, which straighten the leg, and drive down the treadles, the way on the machine carrying the wheels round and diminishing the work to be done in lifting the legs. The arms, of course, also do effective work in guiding, the muscular tension involved in keeping the levers in the proper position involving steady effort, though an expert rider can so balance himself as greatly to diminish the strain upon the arms. On a level road, for example, the experienced rider can go a considerable way without his hands on the handle at all, so nice are the muscular adjustments which maintain the balance, but whenever any difficulty on the road occurs the muscles of the arms are at once and actively engaged. After a ride of long duration, the fact that a large number of the muscles of the body have been unconsciously engaged in the work is evident from the feeling of general fatigue, not fatigue limited to the legs or ankles or arms, but affecting also the loins and back. Now, on the tricycle the necessity of a fine adjustment of the body is not so needful, and certainly not so urgent, because the machine maintains its own balance. If the height of the saddle is properly adjusted, the rider is almost in the erect position and bears with a large proportion of his weight upon the treadles, but if his seat is somewhat low he will speedily become aware of the position of the most active muscles from the feeling of intense strain and weariedness in the muscles of the front of the thigh, the muscles which straighten the legs and thus drive down the treadles. In this case his weight is mainly borne on the seat and is largely lost as a means of propulsion. In the case of the tricycle, however, the extra weight of the machine, the increased friction from the number of wheels, and the diminished diameter of the wheels, necessitate a greater expenditure of energy for the same distance covered. Dr. James Cantlie thus calculates the expenditure of energy in the driving of the bicycle: "Take, for example, a bicycle with a wheel of 60 inches diameter, every stroke with the foot causes the wheel to travel half its circumference, or nearly 7½ feet, that is 90 inches. This is equivalent to three regulation walking steps of 30 inches; and not only so, but the impetus given to the bicycle by one stroke would carry it much further, whereas a step in walking gives no further 'way' on the body. Hence each stroke becomes lighter after the first, and less and less exertion is required to keep the machine in motion. From all these reasons, then, and from actual observation of the effect of comparative distances travelled, it is plain that to travel a mile on a bicycle is equivalent in muscular expenditure to about one-sixth of that expended in walking a like distance. The exertion spent in travelling a mile on the 'level' on a bicycle is not more than four foot-tons, so that, as 300 foot-tons is the calculated amount of daily exertion (see p. 751) necessary to expend to keep a man in health, an 80-mile ride can be undertaken by a man without danger of overdoing it. No road, however, is level or smooth; hence it is nearer the truth when the exertion expended is considered to be six foot-tons a mile; limiting the distance which ought to be travelled to less than 60 miles a day, if one is to keep within the bounds in regard to the energy expended. Of course, a healthy man can do much more than 300 foot-tons a day, but an exertion greatly over that amount cannot be continued day after day without injury to the health." He calculates that 40 miles a day is about the maximum distance that ought to be attained on a tricycle, and at a rate of not more than six miles an hour.

When one considers the distance that can, after a little practice, be covered easily in an hour or two by even the tricycle, one perceives the value it possesses as a means of exercise. In half an hour one can be rid of the town and out in the open country, getting with the exercise the fresh air, perhaps not otherwise attainable, without risk and, after the initial cost of the machine, without expense. It is a suitable exercise for women as for men, for the elderly as for the young.

There is, however, great temptation to put on speed and to cover startling distances in the minimum of time. Any one who has seen a young man dismount from his bicycle with every vein of his face and head standing out, and with his face turgid with exertion, and purple from deficient respiration, does not need to be told that in this exercise, as in others, the pace may kill. The concentration of effort in the legs, for the attainment of speed, almost necessarily involves a fixing of the chest, as well as the strain put upon the arms to maintain a straight course by pressure on the handles. This means insufficient breathing, want of aeration of the blood, breathlessness, and so on. Beginners are apt by the vigour of their grasp to produce this fixing of the chest and speedy breathlessness, even when trying to go at no more than a moderate speed.

The vibrations communicated to the body by stimulating the abdominal organs are useful in certain sluggish states of the bowels, &c., such as may be a cause of indigestion, constipation, &c. But the bicycle should not be mounted by any suffering from heart or lung affections or with a tendency to rupture. They should have medical advice before using even a tricycle. The writer is not sure that a bicycle, or tricycle even, is a useful means of exercise for anyone suffering from marked disorder of the liver. It ought to be useful, by the stimulus it occasions, to slight sluggishness of liver, *if the exercise is taken in moderation and at a gentle speed*, but he is convinced he has seen it do much harm, in the case of a youth who was very fond of the machine and indulged in long rides, and was fond of making good records.

The dress should be of light woollen material, and well-fitting without being tight, that is the usual amplitude of garments is undesirable; a waterproof coat should be carried, and the cap should be of woollen material. Specially should the neck be free of constriction, and the loins, the knees also. Stockings should be kept in position by some other method, rather than by the tightness of knickerbockers, or anything of the garter kind. Ladies should wear light flannel garments, of no unnecessary length; and the objection to constriction applies to common articles of their dress which have already been objected to at sufficient length in this work (p. 472).

Cricket and Football vary very much in the amount of exercise they give to the body, which depends on the part the individual player must take in the game. The individual must merge himself in the body of men with whom he is associated. The game of cricket supplies all that an exercise should, work for the whole body, needing quickness of eye and alertness of judgment as well as good muscular development. For boys at school it is the most excellent of games, provided a boy plays with others of his own size and years, who will consequently bowl and hit with a strength to which he is equal. Its chief evil is the waiting about necessary before one has his turn at the wickets, during which the cricketer is not too careful to don an extra garment. In the game of football more risks are run than in any other. It calls for sudden efforts, to be followed by periods of waiting of longer or shorter duration. In consequence the pressure on heart and lungs is often very great, and the risks of lung affections from cold by no means small, not to speak of the frequency of accidental injury.

For both games a little training, of the kind which strengthens the organs of circulation and respiration, should be undertaken before the season begins. The best for this purpose is the training for running, which is given in detail on p. 754.

Golf, a Scotch game to begin with, is now rapidly becoming popular all over the United Kingdom. It is the perfection of an outdoor game. It implies walking at a steady even pace without hurry or excitement, abundant exercise, though not excessive, to the arms, an education to the eye in estimating distances, and a training in graduating the amount of force to be used to send the ball the needful distance, and the niceties of the game afford an educational influence of great variety and high order. It is a game enjoyed by both sexes, and at all ages; and one may say there is no disease, which does not prevent one wielding a club, in which it would be improper.

GYMNASTIC EXERCISES.

Gymnastic exercises are too often regarded from too narrow a point of view. Many people think of a gymnasium as a place where youths are put through a course of exercises to enable them to accomplish some particular feat, or to acquire some particular kind of dexterity. It is a place where one learns to fence, to leap, to turn somersaults and so on. This is not a correct view, though it is one unfortunately encouraged by the bad system pursued in many gymnasia, where the pupils are set to practise certain limited movements, the aim being to achieve a certain result in the length or height of a jump and so on. The result of any training, the chief end and object of which are the accomplishment of some feat or several feats, is that certain muscles of the pupil's body are developed to a great degree, while others are developed to a much less degree or are neglected. The consequence is a disproportion of parts, a want of harmonious growth and development of the whole body. It is commonly the lower limbs that suffer in this way, the upper part of the body being developed out of proportion to them. Now there is nothing in the term gymnastic restricting the kind of exercise. It is derived from the Greek, *gymnos*, naked, simply because the Greek stripped to his exercise; and the word does not, therefore, indicate the kind of exercise, but simply that the athlete removed all possible clothing so that there should be no hindrance to the full exercise of his whole body. Now the only aim, which gymnastic exercises should have, is the methodical training of all the muscles of the body for the purpose of promoting the highest possible development of all the powers and activities of the body, consistent with health. The object is not the accomplishment of a feat, which can be paraded on exhibition, but the perfecting of the physical framework of the body. As we have already pointed out such perfecting of the physical framework of the body, when not unduly pursued, is not without marked influence on the mental and moral sides of the individual. Such exercises then ought to be considered as essential parts of a good all-round education. Education, that is to say, ought not to be restricted to the intellectual powers. It ought to include the training of the body, and as a result one would have more frequent illustration of the "sound mind in a sound body" than is yet common. Gymnastic exercises ought to include every kind of muscular movement that is fitted to promote a harmonious development of the healthy body as a whole. They ought not to be looked at as the appropriate exercises for the production of athletes, but the necessary training for the production of healthy men *and women*.

It is to Peter Henry Ling, who was born at Smaland, in Sweden, in 1766, that we are indebted for a scientific system of bodily exercises. Student of theology, tutor, naval volunteer, and teacher of modern languages in turn, Ling, in 1806, became fencing master at the university gymnasium at Lund, Sweden, where he began to put in practise his views of a rational method of gymnastic exercise. Finally he was made a professor at Stockholm and director of a central establishment, founded for the practice of his system of movements, a system which was subsequently introduced into all the military academies of Sweden, town schools, universities, colleges, and even into orphan institutions and country schools. In the central institution the movements were also applied for the treatment of disease. Ling's idea was that "an harmonious organic development of the body, and of its powers and capabilities by exercise, considered in relation to the organic and intellectual faculties, ought to constitute an essential part in the general education of a people." He based his system of gymnastics on anatomy and physiology, each movement being designed for the exercise of a particular muscle or group of muscles, and the whole set of movements thus affording effective and appropriate work to all the various muscles, without unnecessary exertion or fatigue on the part of any. The design of such a system implies, therefore, a knowledge of the actions proper to each muscle or group of muscles, and the movements by which each can be brought into activity.

Nowadays, chiefly owing to the teaching of Ling and his pupils, methodical and graduated muscular exercises are employed both for the development of the healthy body and for the treatment of disordered states, such, for example, as spinal curvatures. In lateral spinal curvature, indeed, graduated muscular exercises afford almost the only suitable kind of treatment. There are many books now to be had, well illustrated, in which a great variety of exercises suitable for children and youths are well described, the performance of which is well fitted to develop the body in a healthy way. We shall give here only such exercises as might be made use of in any home, which require little or no apparatus, and which at the same time will put into action most of the muscles of the body.

EXERCISES WITHOUT APPARATUS.

If several persons are about to engage in the exercises, let them stand in line about 6 feet apart; let the instructor stand a little in front opposite the centre of the line. When he gives the word of command he should himself, at least at first, go through the movements, so that the pupils are aided in understanding their exact character.

The **position** in which each pupil should stand is that of **attention**, as it is called in the army. It is thus described:—The exact squareness of the shoulders and body to the front is the first and great principle of the position. The heels must be in line and closed. The knees should be straight, the toes turned out so that the feet may form an angle of 45°, the arms hanging easily from the shoulder, the hand open, the thumb to the front and close to the forefinger. The fingers should lightly touch the thigh, the hips being rather drawn back, and breast advanced, but without constraint. The body should be straight and inclining forwards, so that the weight of it may bear principally on the fore-part of the feet. The head is to be erect, but not thrown back, the chin being slightly drawn in, and the eyes looking straight to the front. This position is given in Fig. 297.

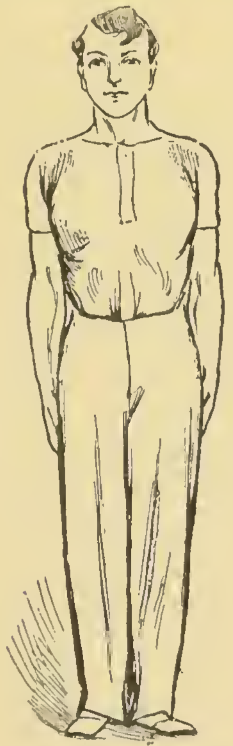


Fig. 297.

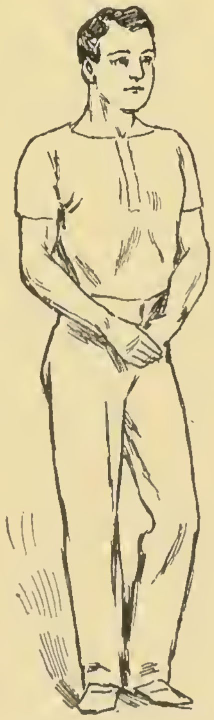


Fig. 298.

Stand at Ease is the next position to be taught. The arms are raised from the elbows, the right one as high as the right breast, with the palm directed to the left and to the front, the left one as high as the waist, with its palm upwards. During the movement the thumbs are separated from the forefingers, and throughout it the elbows are kept steadily pressing against the sides. This is the first part of the movement. At the next part the pupil strikes the palm of the right hand on that of the left, the arms are dropped to their full extent, the hands keeping together, and as they fall the right hand slips over the back of the left. At the same time the right foot is drawn back 6 inches, so that its instep is placed against the left heel. The weight of the body is supported on the right leg, the left knee being slightly bent (Fig. 298). In this position the whole attitude should be without constraint, the arms should hang loosely and easily, the fingers pointing towards the ground, the right thumb being lightly held between the thumb and palm of the left hand.

When the teacher has shown to each pupil the correct positions, he should exercise them in taking it together. Standing in front he gives the word of command, dividing the command into two halves, thus, *Stand at—Ease,* pausing for an instant after the first half, so that the children, knowing what is to come are all ready to act together when the second half is called out, in a quick, sharp tone. The first half is called, the **caution**, and is the signal to be ready. The orders are thus:—

Atten—(pause) *tion ; Stand at—*(pause) *Ease.*

Those orders should be given several times, one after the other, say six or eight times, till the pupils get accustomed to assume the positions quickly *and all together.*

The caution is made a little longer, so that a little more warning is given, by the instructor calling out *Boys* (or *Girls* as the case may be) before giving the order, *Attention,* just as in army drill the officer precedes his order by the word *squad, company,* &c., according as he is addressing a squad or company.

First Arm Exercise.

Let the pupils stand in position of attention, and let them then be put through the following movements:—1. The arms are quickly bent at the elbow joint, the elbow being held well back and close to the side; the fingers are slightly bent, their points touching the shoulders. 2. The arms are rapidly raised and fully stretched above the head, the palms *being turned inwards.* 3. The arms, fully stretched out and without the least yielding at the elbow, are brought rapidly down, till they extend straight outwards in line with the shoulders, palms *downwards.* 4. The position of attention, the position from which the movements began, is resumed.

The instructor, standing in front of the line of pupils, would conduct this exercise as follows, and by the following commands:—

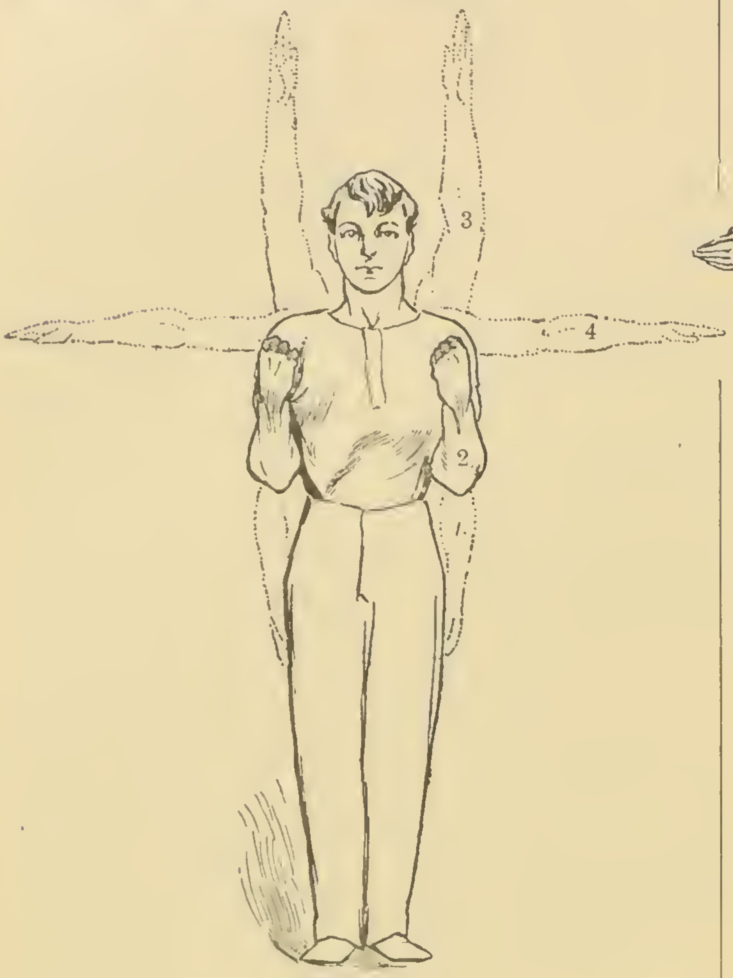


Fig. 299.

Boys (or *Girls*), *Atten—tion.*

For First Arm Exercise (this he calls out to let the pupils know what movements they are to execute). Then, *One* (the pupils assume position 2 of Fig. 299).

Two (,, ,, ,, 3 ,, Fig. 299).
Three (,, ,, ,, 4 ,, Fig. 299).
Four (,, ,, ,, 1 ,, Fig. 299).

This exercise should be repeated eight times. End with the order *Stand at—Ease.* It may be varied by causing the pupils to perform it with one arm only. The instructor, in giving the caution *For First Arm Exercise,* would add—*with right* (or left) *arm only.*

Second Arm Exercise.

The pupils first get the command *atten—tion,* springing at once into the proper position. The movements they are now put through are as follows:—1. The arms are thrown straight up to their full height, as in 3 of Fig. 299. 2. The arms are stretched straight out in front, palms together, as in Fig. 300, the elbows being kept perfectly straight in executing the movement. 3. The arms are swung, fully stretched, to the back, and kept there, palms being struck together. This movement is a difficult one. The instructor must see that in this position the shoulders are straight, head well up, but chin drawn in, and eyes to the front (Fig. 301). 4. The arms are swung, fully extended, to the position of number 2, Fig. 300. 5. The first position, that of attention, is resumed.

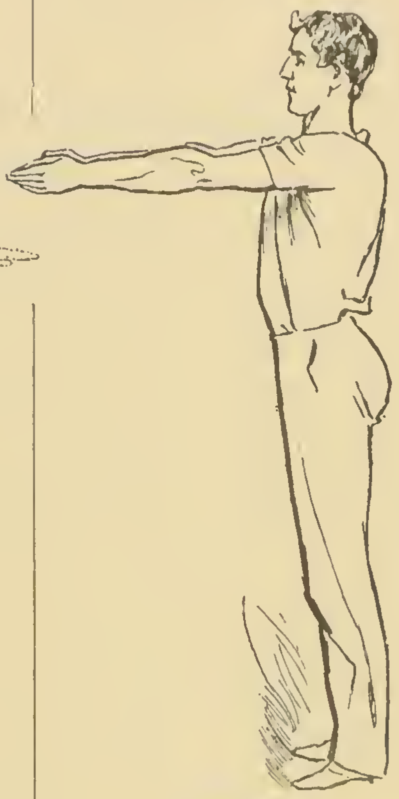


Fig. 300.

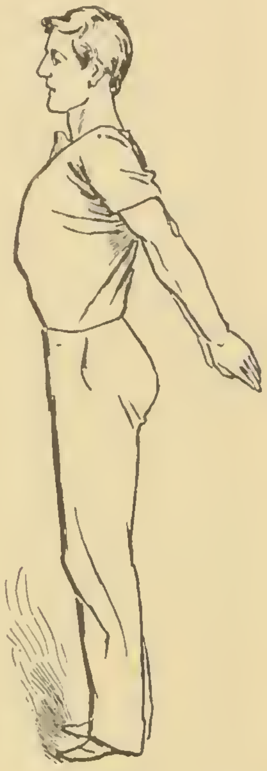


Fig. 301.

The commands for this exercise are consequently as follows:—

Boys (or *Girls*), *Atten—tion.*
For Second Arm Exercise—

One (position shown as 3 of Fig. 299).
Two (,, ,, in Fig. 300).
Three (,, ,, ,, Fig. 301).
Four (,, ,, ,, Fig. 300).
Five (,, ,, ,, Fig. 297).

Repeat this exercise six times. End with the order—*Stand at—Ease.*

Third Arm Exercise.

From the position of attention the following movements are made:—1. The arms are swung, fully extended all the time, outwards and upwards till they are stretched, straight above the head, *palms to the front* (Fig. 302). 2. The arms are brought down, at the stretch, till they extend straight out in line from the shoulders, *palms upwards* (as in 4, Fig. 299, with the difference of the palms being upwards instead of downwards). 3. The upper arm being kept steady, the elbows are rapidly bent, and the fingers brought to touch the tips of the shoulders (Fig. 303). 4. The position of number 2 is resumed. 5. The arms are brought down to attention.

The commands for this exercise are:—

Boys (or *Girls*), *Atten—tion.*
For Third Arm Exercise—

One (see Fig. 302).
Two (,, Fig. 299).
Three (,, Fig. 303).
Four (,, Fig. 299).
Five (the position of attention).

Repeat this exercise eight times. End with the order—*Stand at—Ease.*

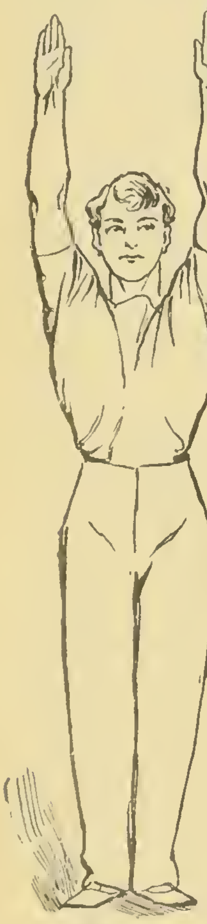


Fig. 302.

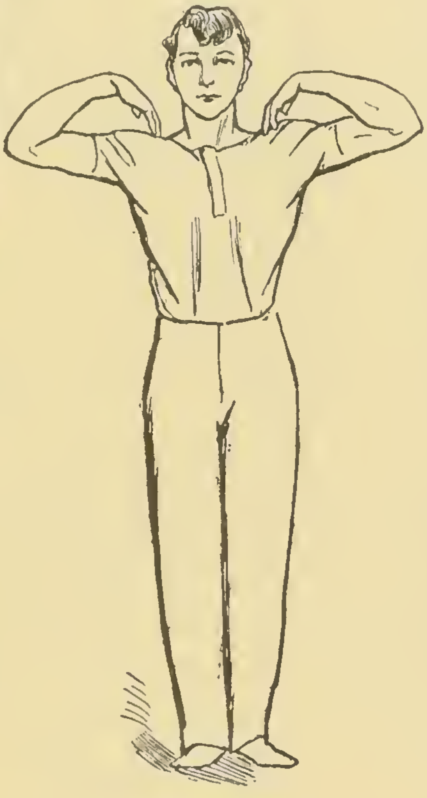


Fig. 303.

These exercises bring into activity the muscle which bends the forearm at the elbow—the biceps (see Fig. 67, p. 72), the muscle which straightens the arm—the triceps, the muscles which raise the arm, of which the deltoid and trapezius (p. 72) are the chief, the muscles of the back, which, acting from the spine, pull the arms backwards, the muscles which clothe the chest and carry the arms forwards, and the muscles which turn the hand into the prone and supine positions. But they do more: they act vigorously in expanding the chest. When the arms are strongly extended above the head, the ribs are raised, the cavity of the chest is enlarged and the lungs in consequence are more distended with air, and the vigorous pull on the shoulders by the backward movements of the arms has a similar effect.

While the pupils are being put through these exercises they must be cautioned against holding their breath. They ought to breathe freely and deeply all the time, never holding the breath at all. If the breath is held, and at first many will be found to do so, the pupil will be rapidly tired, simply from want of air. But if breathing is steadily and regularly maintained, fatigue will not quickly appear. Further the teacher must, at the beginning, be content with one exercise, repeated a few times. As progress is made several exercises may be gone through, one after the other.

When the pupils become accustomed to the movements, they must be caused to perform them with speed and energy. The arms must be extended, for example, with force, as if to hit something, and no matter how many children are in the line, the arms should shoot out, instantly at the word of command, as if from one body.

When the children have become acquainted with the exercises they may execute them to music, or, after they have been arranged in line and have assumed the "attention" position, they may, at a word from the instructor, proceed with them themselves without further command, the whole company acting together and chanting the numbers—*One—and two—and three—and four*—repeating the exercise over and over again till the instructor may call the halt. All this time the instructor simply watches the movements, seeing that all the children work together and keeping the whole line in order.

Head Exercise.

From the position of attention the following movements are made:—1. The hands are placed on the hips, fingers being in front and thumbs behind (Fig. 304). 2. The head is slowly bent backwards, the rest of the body being unmoved (Fig. 305). 3. The head is bent slowly forwards (Fig. 306). 4. The head is inclined to the right (Fig. 307). 5. The head is inclined to the left.

The commands would be given—

Boys (or *Girls*), *Atten—tion.*
For Head Exercise—One, &c.

This exercise should be repeated eight times. End with *Stand at—Ease.*

First Body Exercise.

From the position of attention, 1. Take the position shown in Fig. 308 by placing the hands on the hips and carrying the left foot 12 or 14 inches to the left. 2. Bend the body backwards as far as possible, the head being well thrown back and the knees kept stiff (Fig. 309). 3. Bend as far forwards as possible, the chest being well out and head well back (Fig. 310). 4. Bend the body to the left (Fig. 311), and then to the right. 5. Resume the position of attention.

The commands are—

Boys (or *Girls*), *Atten—tion.*

For First Body Exercise—One, &c.

Repeat this exercise twelve times, and end with *Stand at—Ease.*

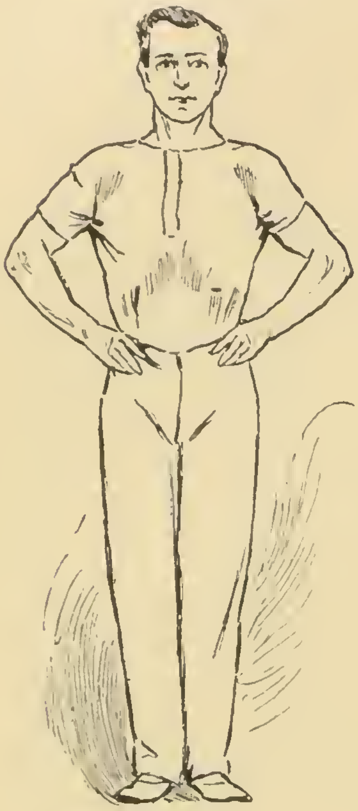


Fig. 304.

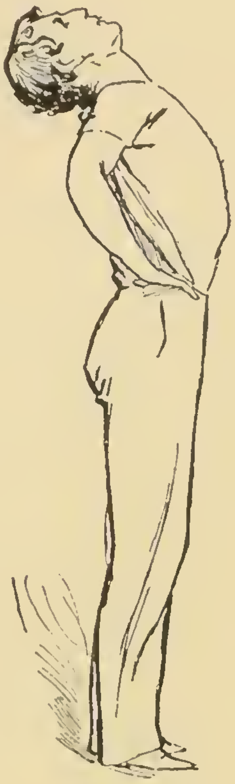


Fig. 305.

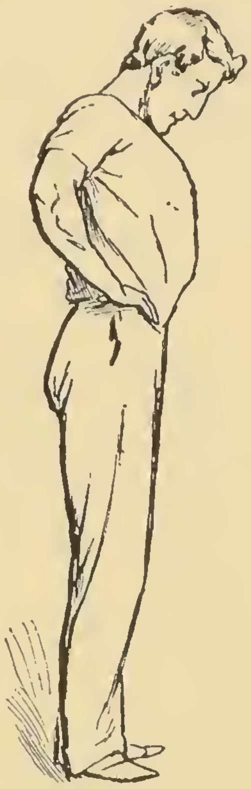


Fig. 306.

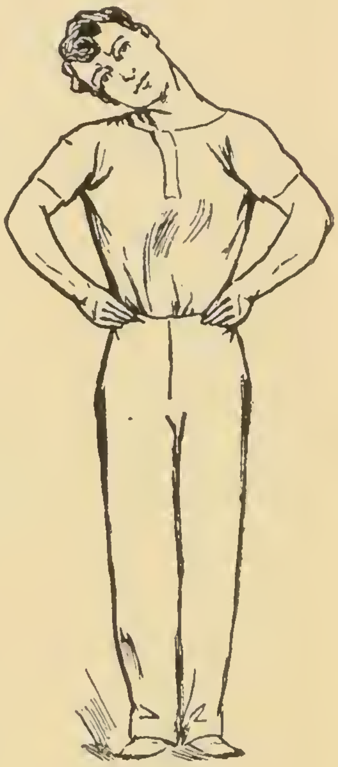


Fig. 307.

Second Body Exercise.

From the position of *attention* the following movements are to be performed:—1. Both arms are kept straight, the right is raised as high as possible above the head, *palm outwards*, and the left arm is stretched down, close to the side, as far as possible, shoulders being kept square to the front, back well hollowed so that the chest stands out, and the body well bent over to the left at the waist, the eyes looking to the right hand. 2. The right arm is brought down, and the left raised, the body being now bent over to the right, and the eyes turned to the left hand. 3. The left hand is now swung, *palm inwards*, sideways to the right, by a circular movement, and as it comes level with the right hand, both arms are raised high over the head, the backs

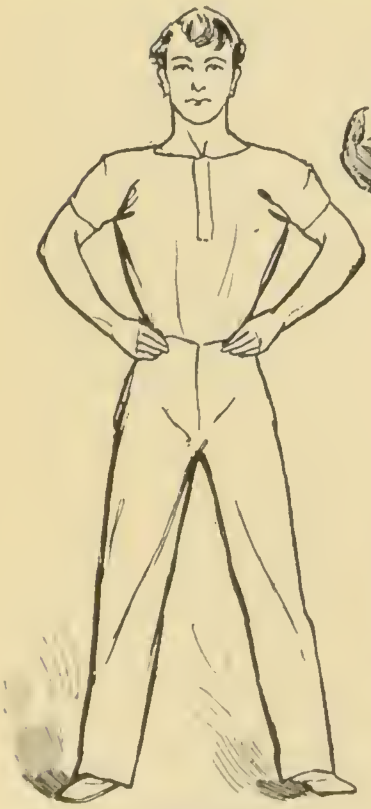


Fig. 308

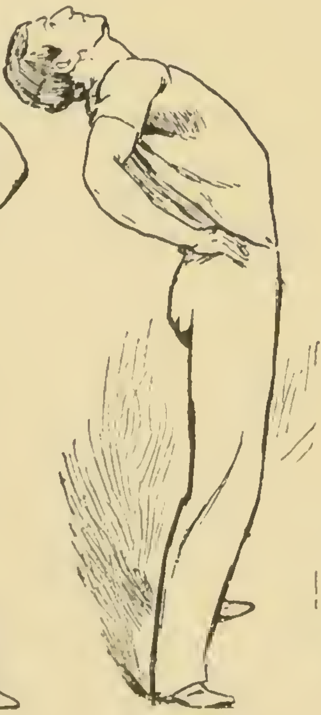


Fig. 309.

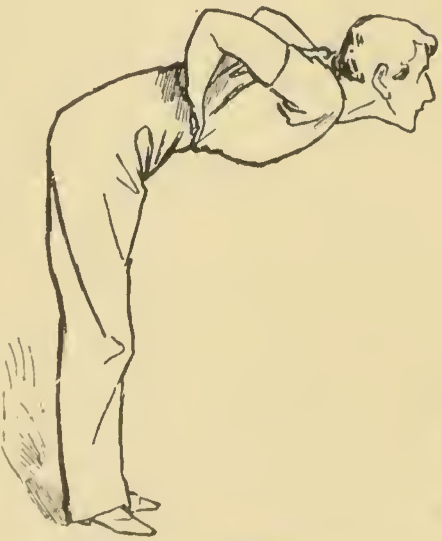


Fig. 310.

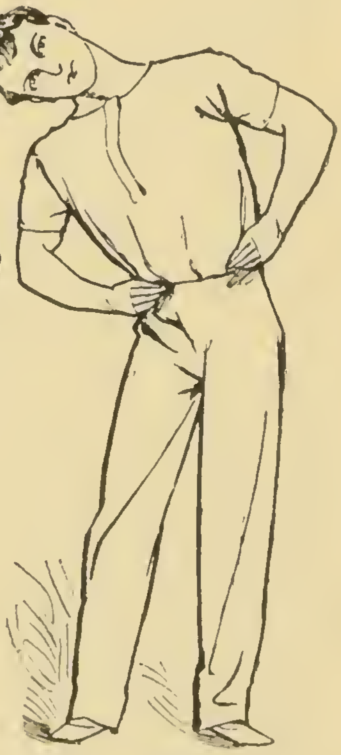


Fig. 311.

of the hands towards the face; the body is turned on the hips to the right and bent over to the left, the head being thrown back and the eyes looking to the backs of the hands. 4. Both arms are swung down by the front and up to the left, the body being turned to the left and bent to the right (Fig. 312). 5. Resume the position of attention.

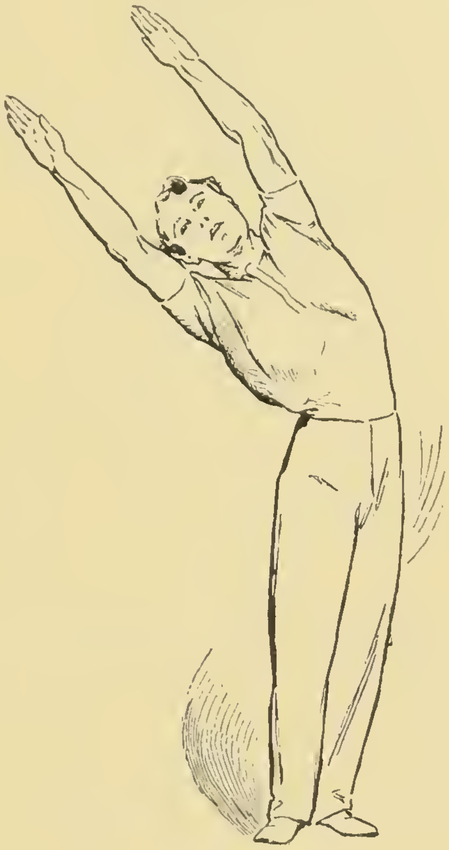


Fig. 312.

The commands for this exercise are—

Boys (*or Girls*), *Atten—tion.*

For First Body Exercise—One, &c.

Practise this exercise eight times, and end with *Stand at—Ease.*

Third Body Exercise.

From the position of attention, 1. Raise the arms as high as possible, palms outwards. 2. Bend quickly down and touch the ground in front of toes with the tips of the fingers, keeping the knees straight (Fig. 313). 3. Quickly straighten the body and then bend as far back as possible, the arms making a circular sweep till they are stretched beyond the head, palms outwards, the head being well thrown back and the eyes directed to the backs of the hands. 4. Straighten the body, and bring the arms to the position of attention.

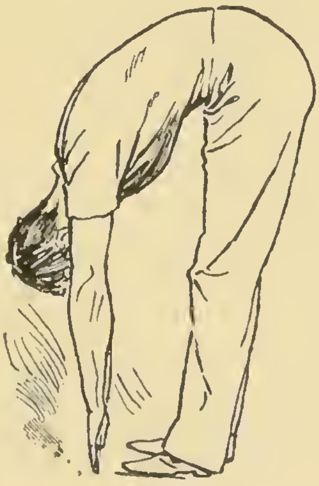


Fig. 313.

The commands are—

Boys (*or Girls*), *Atten—tion.*

For Third Body Exercise—One, &c.

Practise this twelve times, and end with *Stand at—Ease.*

The special use of these exercises is to strengthen the great muscles passing up the back along each side of the spine (see p. 71), and the muscles passing between the trunk and the lower limbs, specially the psoas iliacus and glutei muscles, noted on p. 73.

First Leg Exercise.

From the position of attention, 1. Smartly raise the hands and place them on the hips, fingers to the front, thumbs to the rear, elbows and shoulders well forced back (Fig. 304). 2. Rise on the toes as high as possible, legs being kept straight (Fig. 314). 3. With the head erect and elbows well back, gradually lower the body, bending the knees, till the body just touches the heels, which latter must, as far as possible, be kept together, the knees being forced well apart (Fig. 315). 4. Raise the body, straightening the knees, without bringing the heels to the ground, and then lower the heels to the ground. 5. Resume the position of attention, the arms being dropped quickly to the side.

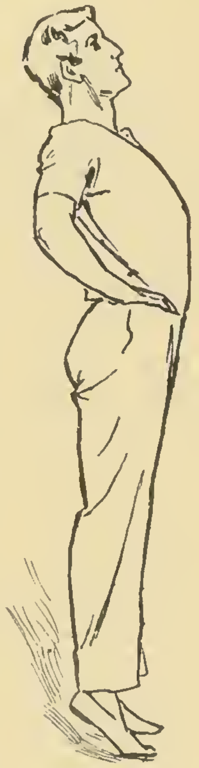


Fig. 314.

All the motions except 1 and 5 are to be performed slowly. In 2 and 3 the body must be kept upright.

The commands are—

Boys (*or Girls*), *Atten—tion.*

For First Leg Exercise—One, &c.

Repeat this twelve times, ending, as usual, with *Stand at—Ease.*

The second movement of this exercise brings into special activity the gastrocnemius muscle, which forms the calf of the leg and by whose contraction the heel is pulled up (see p. 74). Many other muscles are, of course, involved.

For instance, the knees are kept from yielding by the rectus muscle in front of the thigh (Plate II. 8 of fig. 3), while many muscles are concerned in keeping the balance. In the third movement the calf muscles are acting to keep the heels off the ground, muscles in front of the thigh are acting to prevent sudden bending of the knee, and other muscles are on guard similarly at the hip, all this being done against the weight of the body, so that the work is considerable. In the fourth movement the straight muscle of the thigh acts strongly to straighten the leg and so on.

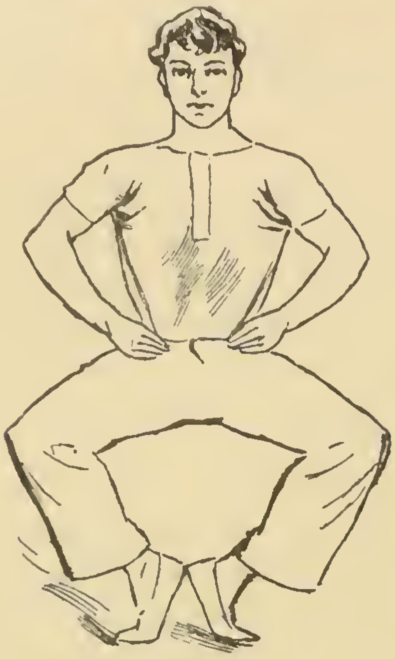


Fig. 315.

Second Leg Exercise.

From the position of attention, 1. Move the hands to a position behind the back, so that the left hand grasps the right arm just above the elbow, and the right hand supports the left arm under the elbow (Fig. 316). 2. Make a partial turn to the right, the right foot pointing to the right, and bring the back of the left heel against the inside of the right foot. The left foot should point straight to the front, and the right should be at right angles to it. The head should be erect, eyes directed to the front, shoulders pressed back and chest advanced (Fig. 317). 3. Take a full step to the front with the left foot, the right remaining flat on the ground. The right leg should be kept quite straight, the knee being well braced back, and the hips pressed forward. The left knee is bent, and is perpendicular to the instep. The body is kept upright and head erect (Fig. 318). 4. Bring the left foot back to the position of 2. 5. Face to the left, so that now the right foot points straight to the front, and the back of its heel is against the inside of the left foot. 6. Advance the right foot in the same way as the left was advanced. 7. Come back to the position of 5. 8. Resume the position of attention, from which the exercise started.

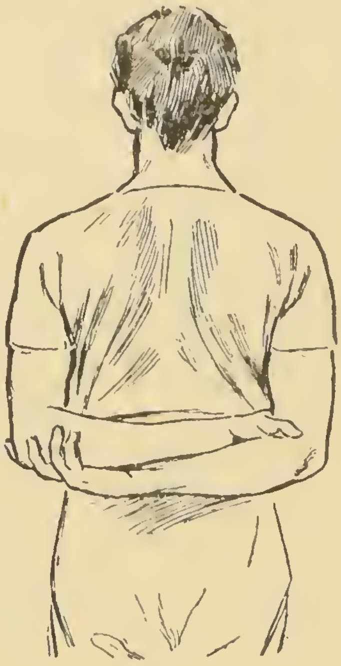


Fig. 316.

The commands will be understood from the orders given under previous exercises.

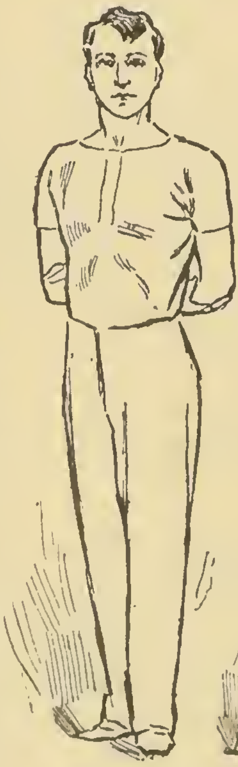


Fig. 317.

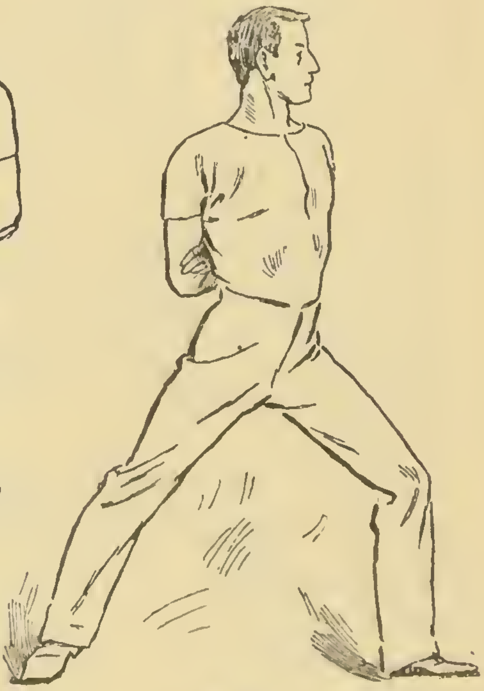


Fig. 318.

Practise this movement twelve times, and end with *Stand at—Ease.*

Third Leg Exercise.

From the position of attention, 1. Make a full step to the left with the left foot, the right being kept flat to the ground, and the leg perfectly straight. 2. As soon as the left foot touches the ground, let the left hand grasp the thigh, just above the knee, thumb inside and fingers outside, the lower part of the left leg and the left arm forming a straight line from the foot to the shoulder, the right arm remaining closely in line with the right leg (Fig. 319). 3. Turn on the heels so as to face the right, and now make the left leg straight and let the left arm be stretched in line with it, and let the right leg and arm assume the position the left is seen to be in in the figure. 4. Return to attention in the original place.

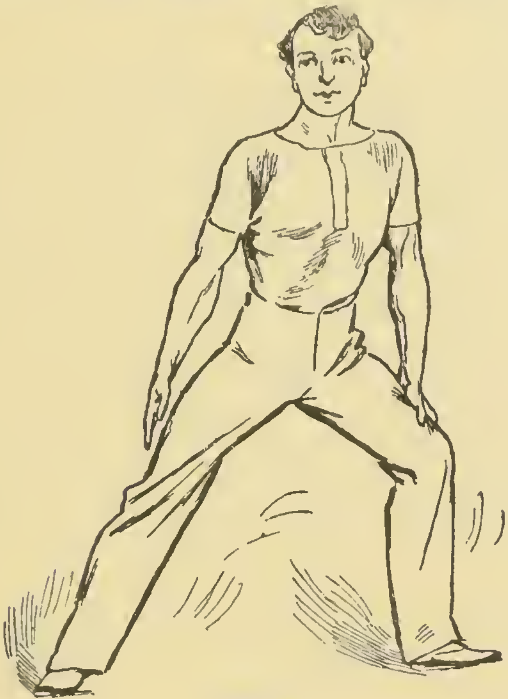


Fig. 319.

Practise this twelve times, and end with *Stand at—Ease.*

Leg and Body and Arm Exercise.

From the position of attention, 1. Move the left foot 10 inches to the left and the right 10 inches to the right, heels being in line, toes pointing outwards, knees slightly bent, and arms hanging straight (Fig. 320) —the position of Fig. 308, but with the legs straight and the arms straight down in line with the legs. 2. Bend the knees till they project beyond the line of the toes, keeping the feet flat on the ground; at the same time bend from the waist and bring both hands to a position between the two feet, closed and placed against one another, knuckles touching the ground (Fig. 321). 3. Quickly straighten the back and legs, carry the arms close up by the sides till they are stretched above the head (Fig. 322). 4. Spring into position of attention.

Practise this sixteen times, ending with *Stand at—Ease.*

Such exercises as have been given in detail are useful only to a limited extent. They cause the various muscles involved to contract, but they give them little work to do. The only work the muscles perform is that of moving the part acted on against the resistance of its own weight. In bending the arm at the elbow, for example, the resistance is the weight of the forearm; in standing on tiptoe the resistance is the weight of the body. Now it has been found that, within certain limits, the more work a muscle has to do, the greater the resistance offered to its contraction, the better is the contraction, and the more valuable is the effect on the muscles themselves. While this is the case, it is not proper to put a heavy strain upon the muscles all at once, nor yet to tax them for a long time on end. The resistance should be small at first, and gradually increased till it reaches an amount, suited for the individual; and the exercise against this resistance should be continued for a short time to begin with, and the period gradually lengthened.

The weight of the body may be made use of to supply resistance for a few simple exercises. Thus let two chairs be placed about two feet apart; let the pupil, standing

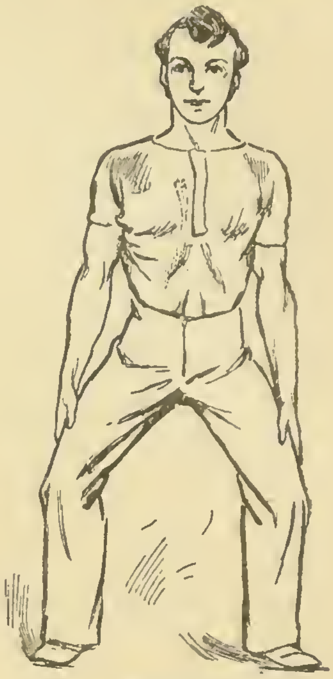


Fig. 320.

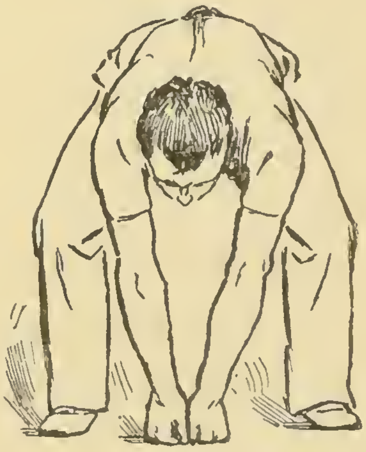


Fig. 321.

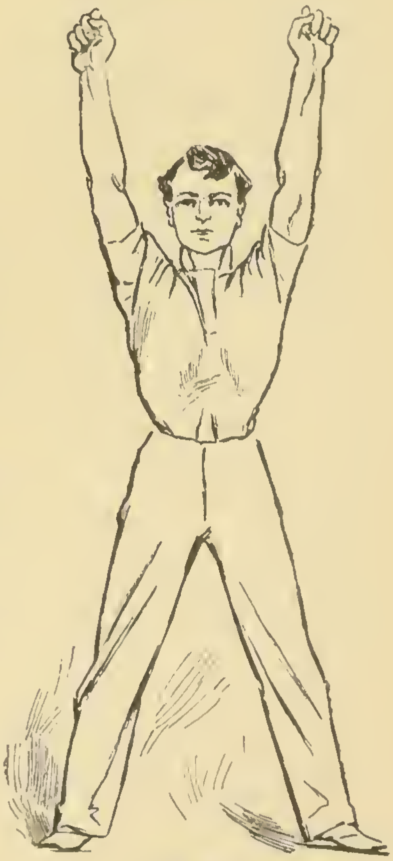


Fig. 322.

between them, place one hand on each, and then step back, keeping the hands on the chairs till the arms are fully stretched; then gradually allow the arms to bend at the elbow till the body is lowered to the space between the chairs, the body being kept all the time rigid. The elbows should then be slowly straightened and the body raised. This is repeated several times. Or again, let the pupil stand between two supports, say school desks, two feet apart, one hand on each. Let him lift himself just off his feet by pressure through the arms, then bending his knees let him slowly lower himself till his knees touch the ground, and then slowly raise himself again. This he will not be able to accomplish all at once, but only gradually after repeated practice.

Dumb-bells are a simple means of giving the muscles work to do. Their weight should be in proportion to the capacity of the pupil, and can be increased in weight as the pupil's strength increases. For children it is recommended that they be made of wood, weighing for boys 1½ pounds each, for youths 2½ pounds. For adults they are made of iron and should be from 4 pounds upwards.

EXERCISES WITH DUMB-BELLS.

First Dumb-bell Exercise.

Let the pupils stand in a row in position of attention (Fig. 297), the bells together in front of the toes. Let the movements of the **First Arm Exercise** be then performed with the bells. At the command—*One*, the pupils bend the body, keeping the legs straight, and, seizing a bell in each hand, straighten the body, bending the elbows up to the position of 2 in Fig. 299, the bells being thus brought up to near the shoulder. At the command *Two*, the bells are raised above the head, the arms being fully stretched, and so on through the other movements of the First Arm Exercise.

The exercise should be repeated eight to twelve times, and, at the end, the command might be given *Down Bells*, at which the pupils would bend the body, keeping the legs straight, and having laid the bells down in front of the toes, would resume the position of attention. They could then get the order *Stand at—Ease.*

Second Dumb-bell Exercise.

This may be the **Second Arm Exercise**, performed with the bells in a way similar to the First Dumb-bell Exercise.

The teacher can thus take as a basis the exercises without apparatus and adapt them to movements with the bells.

The **Third Leg Exercise**, and the **Leg, Body and Arm Exercise** may be used for the bells as follows:

Third Dumb-bell Exercise.

The pupils stand in position of attention, the bells in front of the toes, and the following movements are performed: 1. Make a full step to the rear with the left foot, the right following. 2. Make a half turn to the right, and step to the front with the left foot, the left hand grasping the thigh above the knee, the knee being bent, the right leg being kept fully stretched, and the right arm in line with it as in Fig. 319. 3. Seize the right bell in the right hand (Fig. 323) and raise it as high as possible above the head, the legs maintaining their position unchanged. The left arm is straightened, forming with the lower part of the left leg a straight line from foot to shoulder; and the hand presses firmly against the left knee, the breast being well pushed forward with the lifting of the bell (Fig. 324). 4. Replace the bell, the limbs keeping their position and then quickly spring back into position of attention.

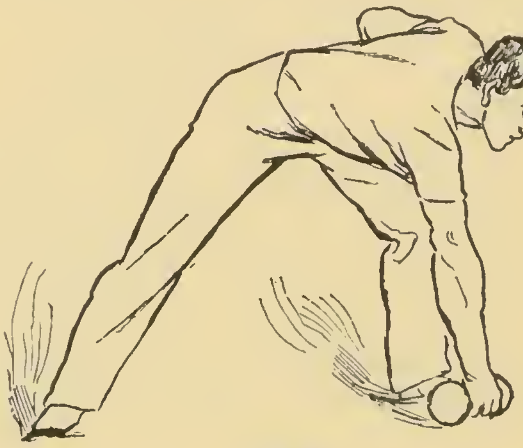


Fig. 323.

This exercise is then repeated, from the other side, the body being turned to the left, the right foot stepping forward, and the bell being seized with the left hand.

Repeat this exercise from the right and left sides alternately sixteen times.

Fourth Dumb-bell Exercise.

From the position of attention, 1. The pupils take a full step to the rear with the left foot, the right following. 2. A half-turn to the right is taken, and then they step to the front with the left foot as in the last exercise; the body is bent over, the left knee yielding, the right leg being kept extended. Both hands pass down, one on each side of the knee, each seizing a bell. 3. The bells are raised high above the head, the left knee being kept bent, and the right leg unmoved. 4. The bells are brought down and replaced in their original position. 5. The pupils spring back to attention.

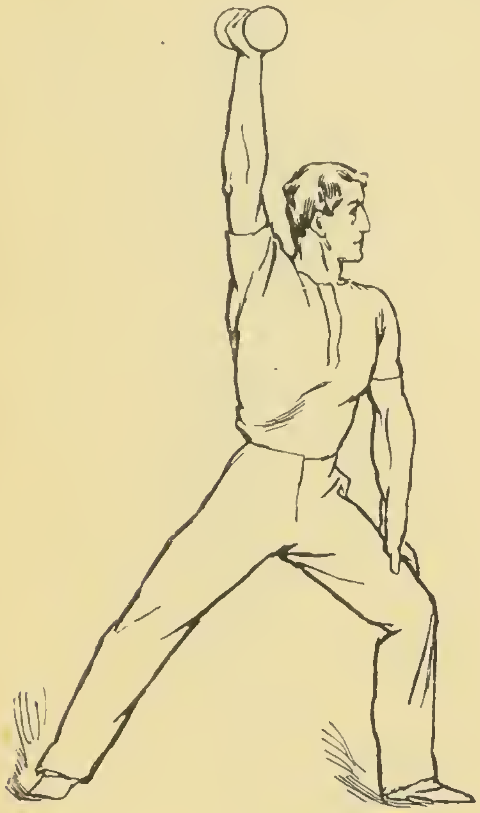


Fig. 324.

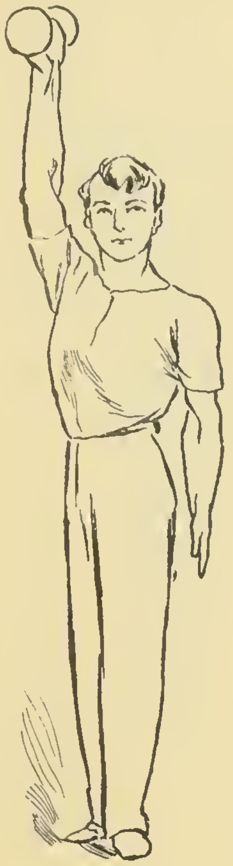


Fig 325.

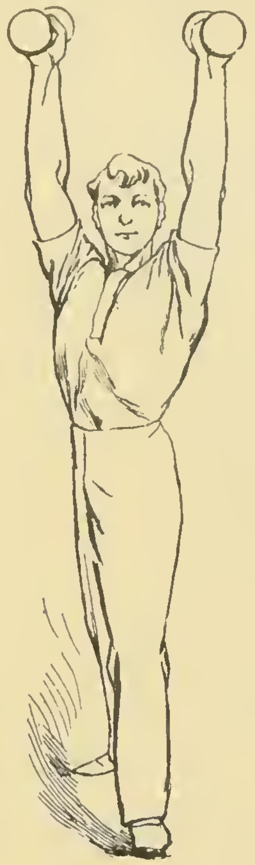


Fig. 326.

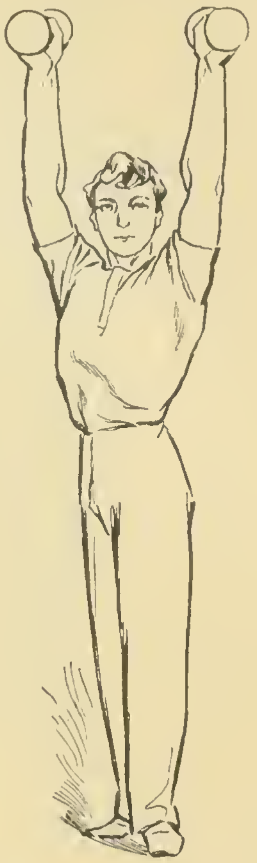


Fig. 327.

This exercise is repeated, but the right foot is put forward, the body facing to the left.

Fifth Dumb-bell Exercise.

I. From the position of attention, 1. The pupils step to the rear as in the preceding exercise. 2. A partial turn to the right is taken, the right foot pointing to the right, the back of the left heel against the right instep as in the **Second Leg Exercise.** 3. They take a full step to the front with the left foot, the right remaining flat. The left knee is bent, the right leg is straight, and bending the body they seize the right bell with the right hand (Fig. 323). 4. The bell is raised high above the head and the body brought back to the position of 2 (Fig. 325). 5. They step again to the front with the left foot, lower the bell, and come back to the position of attention.

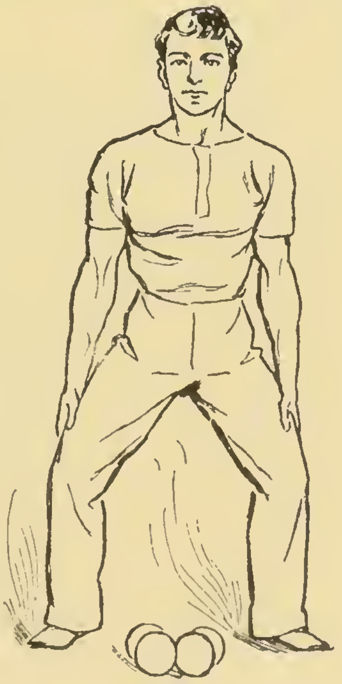


Fig. 328.

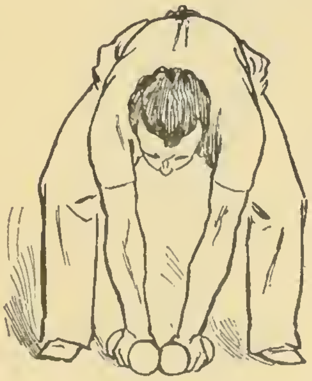


Fig. 329.

II. Repeat this exercise, the pupils turning to the left, putting the right foot forward, and lifting a bell with left hand, the movements being the same as those preceding, but the pupils acting from the left.

III. Repeat this exercise, advancing the left foot, but raising a bell with each hand (Fig. 326), stepping back with them into position of Fig. 327, stepping again to the front and lowering the bell, and lastly resuming the position of attention.

IV. Repeat the same exercise, advancing the right foot, and seizing a bell in each hand.

The teacher can easily distinguish the different parts of this exercise from one another. Thus his commands would run as follows:—

Boys (or *Girls*), *Atten—tion; For Fifth Dumb-bell Exercise; With one bell—from the right—One*, &c.

This would imply the first portion of the exercise; the second portion would be indicated by the caution—*from the left.* The third and fourth portions would be indicated by the caution— *With two bells* and *from the right* (or *left*), as the case might be.

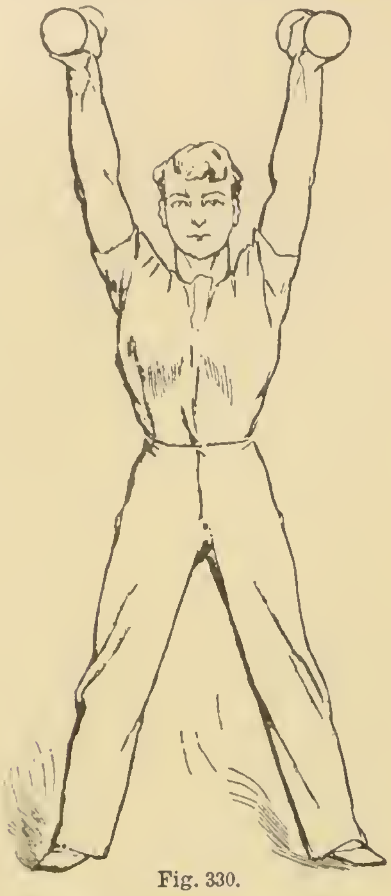


Fig. 330.

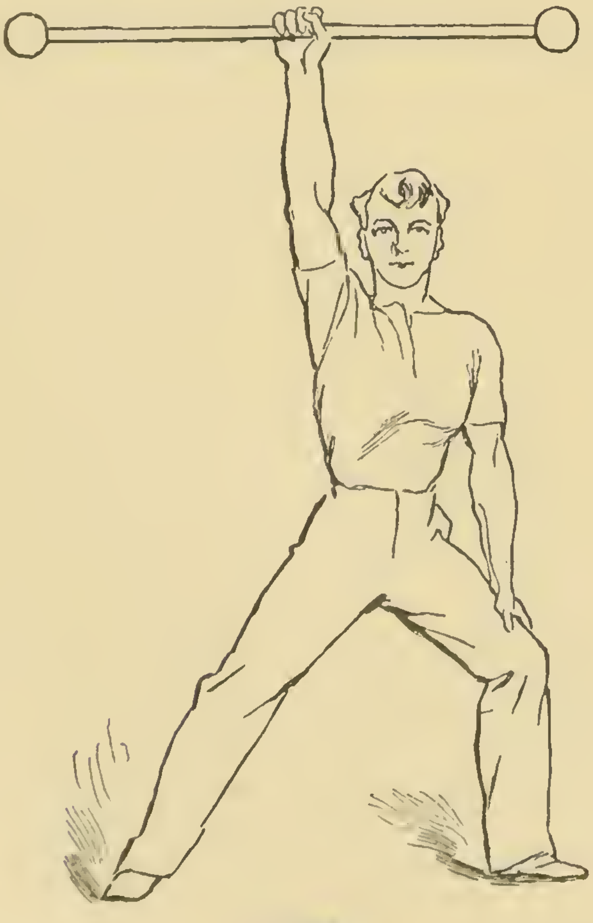


Fig. 332.

Sixth Dumb-bell Exercise.

This exercise is a repetition of the **Leg, Body, and Arm Exercise** (p. 767), but with the bells. 1. From the position of attention the position shown in Fig. 328 is assumed by the movements detailed on p. 767. 2. By the movements mentioned at the same place the bells are grasped, one in each hand (Fig. 329). 3. The bells are raised high above the head (Fig. 330). 4. The bells are lowered as in Fig. 329, and 5. The position of attention is resumed.

BAR-BELL EXERCISES.

The bar-bell is a rod of ash, 5 feet long, 1 inch in diameter, and with a ball at each end. Exercises similar to those with the dumb-bell may be engaged in. Figs. 331, 332, and 333 illustrate movements, the same as those of the **Third and Fourth Dumb-bell Exercises**, and the instructor can make use of other exercises which will readily suggest themselves.

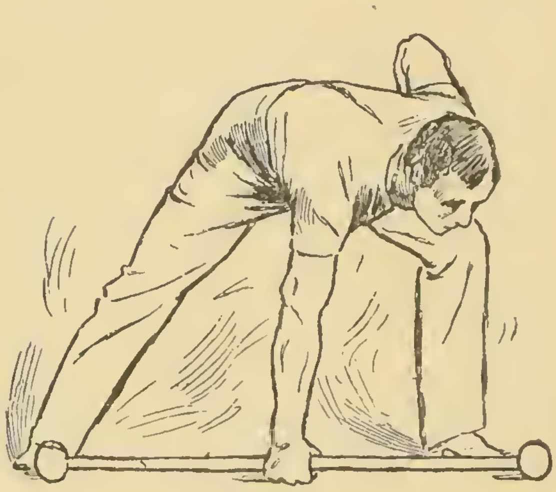


Fig. 331.

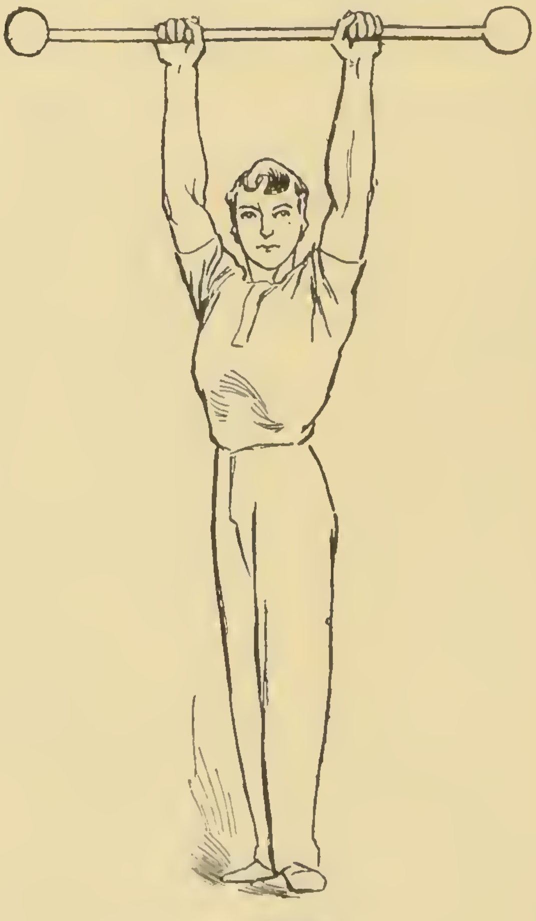


Fig. 333.

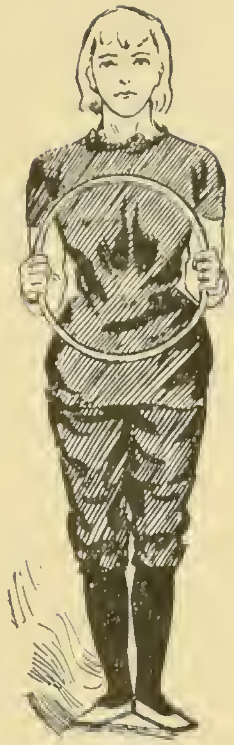


Fig. 334.

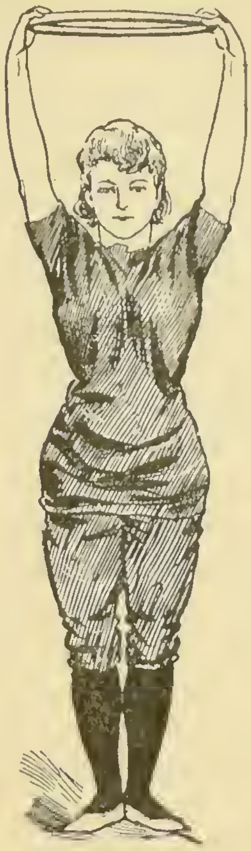


Fig. 335.

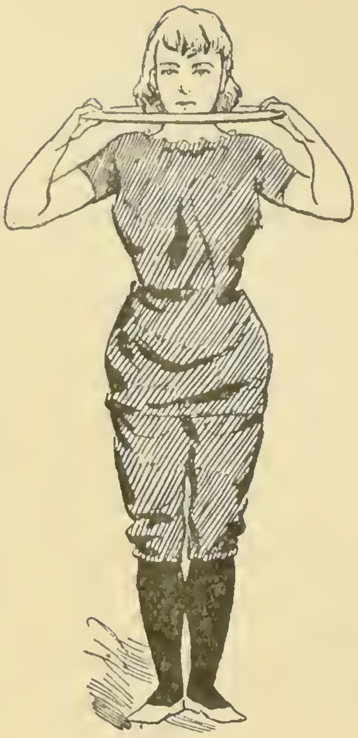


Fig. 336.

HOOP EXERCISES.

For young children the hoop affords a variety of simple and useful exercises. The hoop should be light, 25 inches in diameter.

The teacher who has carefully studied the exercises without apparatus will be able easily to put together a few exercises, consisting of similar movements with the hoops in use, as the following figures show:—Figs. 334, 335, 336, 337, and 338.

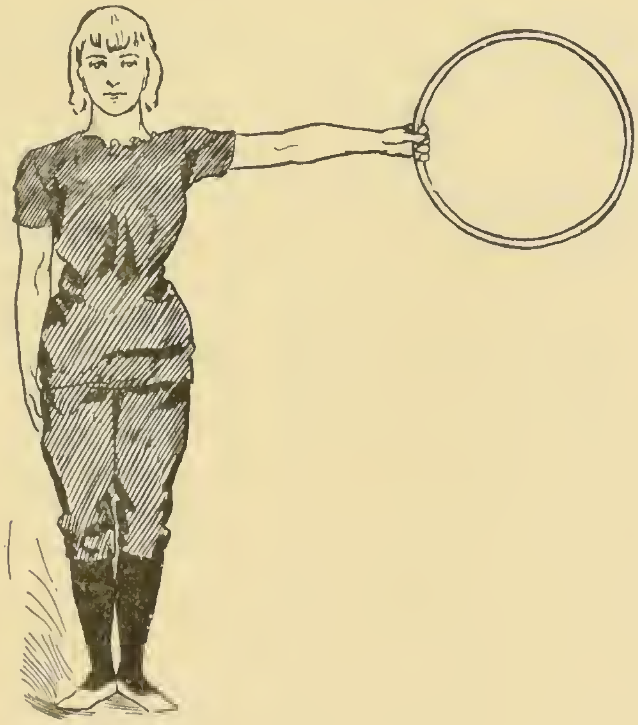


Fig. 337.

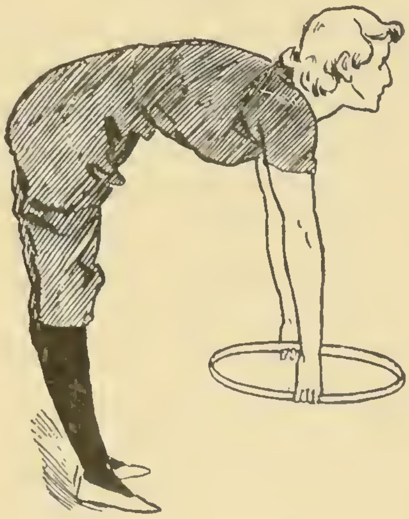


Fig. 338.

The Use of Exercises in the Treatment of Disease: Massage.

Graduated Exercises in Disease.—The employment of exercises for the cure of disease, or what is called **medical gymnastics**, can, it appears, be traced back to the earliest times on record of the Hindoos and Chinese, and was in common use among the Greeks and Romans. Muscular pains and cramps, the results of muscular fatigue, neuralgias, spinal curvatures, were so treated, as well as dropsy and other diseases. In the beginning of the eighteenth century the methods, which had been long neglected, were again brought into prominence by the publication of various works on the subject—one, in 1728, was by a London surgeon, Francis Fuller, called "Medicina Gymnastica"—but it remained for Ling to revive, or rather recreate the treatment, under the modern name of the "movement cure." Ling was led to believe in the possible benefit of muscular exercises by himself getting rid of a rheumatic affection of the arm by fencing. He set himself to study anatomy and physiology, and to investigate the value of definite movements on diseased states. In 1813 he first practised at Stockholm the curative movements. Of recent years, much more extended consideration has been given to the value of movements in disease, largely through the influence of pupils of Ling, and the applicability of such methods is now admitted in cases of rheumatism, neuralgia, sciatica, associated with another form of mechanical treatment called **massage**. Exercises, similar to those described on pp. 761 to 771, are employed, along with manipulations, by some one trained to their proper performance, of the kind described below, and along with what are called **passive movements**, that is movements of the patient's limbs, effected not by himself but by some person grasping the limb and causing the movement to be executed. Such treatment is found very useful, not only in the cases named, but also in sprains, inflammations of joints, stiffness of joints, in various nervous and digestive disorders, constipation, &c. In lateral curvature of the spine various simple exercises, without apparatus, are frequently sufficient to correct the deformity.

Massage is derived from the French *masser*, to knead, although kneading is only one of the manipulations employed in the process. It is not to be confounded with shampooing as practised by a bath attendant; and we are told that to acquire the art of properly giving a massage, implies much preliminary study and very prolonged and careful practice. The objects of massage are, in the first place, to influence the nutrition of the whole body, or a particular part of it, and, in the second place, to promote the removal of swellings, inflammatory products, &c., that disease may have occasioned in any particular place. It is comparatively easy to understand how these effects may be produced. When the masseur (*masseur* is the term applied to the male attendant who gives massage, *masseuse* to the female attendant), when the masseur rubs or strokes the skin, he immediately affects the circulation of blood through it. As his fingers pass over the skin, stroking it with some degree of firmness, he empties the blood-vessels, and when the pressure has passed the blood fills the vessels again with a rush. If he strokes always in the direction of the current, as he ought always to do—from the extremities towards the heart, never backwards and forwards in a random way—the assistance to the circulation is material. But he influences also the lymphatic vessels (p. 200), the vessels by which in particular the products of waste are removed, and he thus stimulates the removal of injurious substances. When he picks up the skin and rolls it, as it were, between finger and thumb, he does the same things more effectually. When he administers a brisk tap or slap with one or two fingers, or with the flat of the hand, the stimulus is again marked, for the skin immediately reddens. Then the masseur also ought to be acquainted with anatomy; he ought to be able to separate out with his fingers a single muscle or a small group of muscles, and treat them in a like way, through the skin, stroking them, squeezing them, kneading them, prodding them with the points of his fingers, or with the edge of his hand, and so stimulating the blood current to them, aiding and hastening the removal of waste from them, and exciting them to contraction. He ought to know the direction in which large vessels run, and the regions in which nerve trunks lie, and he ought to be able to insinuate his fingers between muscles to reach and act upon them also. All this is well fitted profoundly to affect the nutrition of the parts acted upon, and not them only, but also the rest of the body, through the circulation and the nervous system, and is very different from the few minutes' shampoo in the Turkish bath.

A variety of terms is used to indicate the kinds of manipulation employed, such as stroking, rubbing, kneading, pinching, pressing, squeezing, hacking. In some books the French words are used—*friction*, which explains itself, and *effleurage* both apply to the skin, the latter being the movement of rolling the skin between the fingers; *tapotement*, or tapping, and *petrissage*, or kneading, are the means by which deeper structures are reached.

General massage implies that the whole body is treated; partial massage means that it is restricted to some particular part. Half an hour to one hour is the time devoted each day to the process. The process should be performed on the naked skin by the bare hands of the operator, no oil being used; and the hands ought to be strong and firm, but soft, very considerable exertion being expended in the process.

The process is thus described by Dr. Weir Mitchell: "The patient lying in bed, the manipulator starts at the feet, and gently but firmly seizes the skin, rolling it lightly between his fingers, and going carefully over the whole foot; then the toes are bent and moved about in every direction, and next, with the thumb and fingers, the little muscles of the foot are kneaded more largely, and the interosseous groups (see p. 73) worked at with the finger-tips, between the bones. At last the whole tissues of the foot are seized with both hands and somewhat firmly rolled about. Next the ankles are dealt with in like fashion, all the crevices between the articulating bones being sought out and kneaded, while the joint is put in every possible position. The leg is next treated, first as to the skin, then by deeper grasping of the areolar tissue, and last by industrious and more profound pinching of the large muscular masses, which, for this purpose, are put in a position of the utmost relaxation. The grasp of the muscles should be firm, and for the large muscles of the calf and thigh both hands should act together, the masses of muscle being, as it were, twisted around the bone, while the hands alternately contract on them. In treating the firm muscles in front of the leg, the fingers or the two thumbs are made to roll the muscle under the cushions of the finger-tips. At brief intervals the manipulator seizes the limb in both hands, and lightly runs the grasp upwards, and then returns to kneading the muscles.

"The same process is carried on in every part of the body, and special care is given to the muscles of the loins and spine, while usually the face is not touched. The abdomen is first treated by pinching the skin, then by deeply grasping and rolling the muscular wall in the hands, and at last the entire belly is kneaded with the heel of the hand in a succession of rapid deep movements passing round in the direction of the colon (see Fig. 87, p. 131), while somewhat later the whole belly, relaxed by position, may be shaken by a rapid motion of the grasping hands. Pinching or squeezing of the skin is very valuable in certain spinal troubles connected with increased sensation, and in some other cases, if the surface and extremities be very cold; but the best masseuses often omit it, and rely solely upon the deeper grip and rolling of the muscles. The process should not be painful, or more at first than merely fatiguing; but after a time the muscles may be handled with a good deal of strength, without causing other than agreeable results. Too much care cannot be used to cover with stockings and warm wraps the parts after in turn they have been subjected to massage. As to time: at first the massage should last half an hour, but should be increased in a week to a full hour. Sometimes I use it twice a day, but commonly one hour suffices. Women who have a sensitive abdominal surface have, of course, to be handled with care, but in a few days a practised rubber will by degrees intrude on the tender regions, and will end by kneading them with all desirable force. The same remarks apply to the spine when it is hurt by a touch; and it is very rare indeed to find persons whose irritable spots cannot at last be rubbed and kneaded to their permanent profit. The daily massage is kept up through at least six weeks."

Massage has yielded its most remarkable results in cases of nervous disorder of a hysterical kind, in cases of wasting through imperfect nutrition, dependent upon some disturbance of stomach, bowels, or liver, and it has proved valuable in some of the special diseases of women, and in diabetes, while paralysed and contracted muscles are often wonderfully benefited by it.

SECTION VII.—CLIMATE AND HEALTH RESORTS.

Climate.

What is Climate?

- *Temperature as it affects Climate;*
- *Temperature as modified by Elevation above Sea-level;*
- *The Influence of Prevailing Winds;*
- *The Effect of Position of Mountain Ranges;*
- *The Influence of Ocean Currents;*
- *The Meaning of Mean Temperature, &c.;*
- *Moisture of Air as it affects Climate;*
- *Rainfall.*

Effects of Climate in Health:

- *Effects of Excessive Heat and Cold;*
- *Effects of Humidity;*
- *Winds and Atmospheric Pressure.*

Effects of Climate in Disease:

- *Climate suited for Diseases of Lungs and Air Passages*—Consumption, Bronchitis, and Asthma, and Climates suited for them;
- *Climates suited for Heart Affections;*
- *Climates suitable in Diseases of Kidneys and other Abdominal Organs;*
- *Climates suited for Malaria;*
- *Climates for Nervous Diseases;*
- *The Climates for Scrofula and General Diseases.*

Health Resorts.

British Health Resorts:

- *The Isle of Wight, the Undercliff, Ventnor;*
- *Bournemouth, Weymouth, Sidmouth, Exmouth;*
- *Teignmouth, Torquay, Dawlish, Salcombe, Penzance, and Falmouth;*
- *The Channel Islands; The Scilly Isles;*
- *Brighton, Eastbourne, St. Leonard's, and Hastings;*
- *Hythe, Sandgate, Folkestone, Dover, Ramsgate, and Margate;*
- *Yarmouth, Lowestoft, Scarborough, Whitby, Redcar, Saltburn;*
- *Bude, Barnstaple, Ilfracombe;*
- *Aberystwith, Barmouth, Beaumaris, and Llandudno;*
- *Southport, New Brighton, Blackpool, Isle of Man;*
- *Rothesay and Bridge of Allan and other Scottish Resorts;*
- *Queenstown, Glengariff, and other Irish Seaside Resorts.*

Mediterranean Health Resorts:

- *The Western Riviera—San Remo, Mentone, Monaco, Nice, Cannes, Hyères, Genoa*—Their Characteristics, and the Diseases for which their Climate is suitable;
- *Malaga, Ajaccio.*

Other European Resorts:

- *Pau, Biarritz, Arcachon;*
- *Coasts of Norway, Sweden, &c.;*
- *Alpine Climates—Davos Platz, St. Moritz, Meran, Tarasp.*

Atlantic Islands:

- *Madeira, The Canary or Fortunate Islands, The Azores.*

African Health Resorts:

- *Algiers, Egypt, South Africa.*

American Health Resorts:

- *California—San Diego, San José, &c.;*
- *Florida; The Bahamas and Bermuda;*
- *Colorado—Denver, Manitou Springs, Colorado Springs.*

Indian Health Resorts:

- *The Hill Stations.*

Australian Health Resorts:

- *Queensland (Brisbane), New South Wales (Sydney), Victoria (Melbourne), South Australia (Adelaide), Western Australia (Perth), Tasmania (Hobart Town), New Zealand (Auckland, Christchurch, Dunedin).*

CLIMATE.

What is Climate?—The word climate is derived from the Greek, *clima*, a tract or region, and was applied to a portion of the earth included between two circles parallel to the equator. Different regions vary, according to their distance from the equator, in the amount of sun heat and light received, and in other attendant circumstances. Thus the word has come to imply, not the portion of the earth's surface itself, but its condition in relation to sunshine, temperature, character composition and moisture of the air, rainfall, wind, and similar circumstances, in their bearing upon life, and, in particular, human life. The climate of a place is determined principally by the duration of its exposure to the sun's rays, and this depends on its nearness to the equator. A large number of local conditions, however, operate as secondary, but, nevertheless, important factors in modifying this chief element and giving to a climate its distinguishing characters. The principal local conditions are the presence of mountain ranges, proximity to the sea, or, in inland districts, to rivers or lakes, height above sea-level, nature of the soil and vegetation, and so on. The chief of these factors in the production of climate we must give some little consideration to.

Temperature as it affects Climate.—It is the heat derived from the sun that determines the temperature of any place. The circumstances which directly affect the quantity of heat received from the sun by any place are the nearness of the earth to the sun and the direction in which the sun's rays fall upon the place. The latter is much more important than the former. In our mid-winter, owing to the elliptical orbit of the earth, the sun is distant from us more than 3,000,000 of miles *less* than in midsummer, and the lessened degree of heat at the former period, in spite of the increased nearness to the sun, is due to the oblique direction of the rays as they reach us, while in midsummer the rays fall more perpendicularly. Similarly it is at the period of the day when the sun is directly overhead that the greatest degree of heat is experienced. Now we have pointed out (p. 681) that the atmosphere is not directly heated by the sun's rays. The radiant heat from the sun passes through the air without perceptibly warming it, because the air does not absorb heat readily. This is very noticeable where the air is very clear and dry. Thus, on board a whaler, the rays falling on the deck have heated the pitch to the point of making it bubble out of the seams, while, in the shade, ice was forming on the ship's side. The rays falling upon the earth heat it, however, and heat it in proportion to its power of absorbing heat. The earth being heated will warm the layer of the atmosphere in contact with it, this layer becoming lighter by increase of heat will rise, and a cold layer will flow in to take its place, to be in turn warmed, and so on. The temperature of a place, while directly influenced by the exposure to the sun's rays and the direction in which these rays fall, is thus very powerfully influenced by the nature of the soil and its capacity for receiving and giving out heat, since it is only through this process that the atmosphere of the place is warmed. If the surface layer of the earth at the particular place is a good conductor of heat, the heat received by that layer will be conducted downwards into the earth for some distance, and to the extent to which the soil conducts well will the atmosphere have a less chance of becoming excessively warm, since air is a bad conductor. If, on the other hand, the soil is of badly conducting material, the heat will not readily pass downwards, and the atmosphere will receive more heat from the soil. Rocky surfaces conduct well, so also do clay and loamy soils, and the heat does not, therefore, accumulate so much on the surface of such soils. Sand, on the other hand, is a bad conductor of heat, and during exposure to the sun's rays becomes excessively warm. It also has a very high absorbing power for heat, absorbing nearly double the amount of heat that earth (mould) will. Consequently, owing to both these circumstances, the atmosphere over sandy deserts becomes oppressively hot, "the surface temperature of sandy deserts of the tropics rising frequently to 120°, 140°, and more rarely 200°." Moreover, the amount and nature of the vegetation of the district will have a modifying influence on the temperature, for vegetation will protect the soil from the sun's rays to some extent, and by evaporation from leaves, &c., will prevent the temperature of the surface rising so high as it would otherwise do. In a climate of a country covered with vegetation one does not, therefore, find the same extensive variation of temperature within twenty-four hours as is found in a country without vegetation, the vegetation keeping the district cooler during the hottest part of the day than it would otherwise be.

Now during the time that the sun's rays are being poured upon a district, the temperature of the surface layers of the earth is rising, because they are receiving more heat than they are giving out. They are, however, giving out heat to the atmosphere in contact with them, whose temperature is rising also. But when the sun has set, and sometime before then, the earth is receiving little heat and is giving out much, its temperature is therefore falling. During the sunny parts of the day, that is to say, the earth is storing heat, and during the sunless parts of the twenty-four hours it is distributing it. If a great deal is stored and slowly given out there will not be marked extremes of temperature in twenty-four hours, very hot by day and becoming suddenly cold by night, but the heat will be more evenly distributed during the twenty-four hours and a more equable climate will result. As an illustration of this we have already instanced the effects of vegetation. Forests have a very striking effect of this kind. "Trees are heated and cooled by solar and nocturnal radiation in the same manner as other bodies. They do not, however, acquire their maximum temperature till a little after sunset. This occurs in summer at 9 p.m., while in the air the maximum temperature occurs between 2 and 3 p.m. Hence trees may be conceived as reservoirs in which the heat of the day is stored up against the cold of the night. Changes of temperature take place very slowly in the tree, but in the air they are very rapid. Hence the effect of forests on the daily temperature is to make the nights warmer and the days colder, or to give to the climate of countries clad with trees something of the character of an insular climate" (Buchan). Another excellent illustration of the same thing is the modifying influence of large masses of water. Water, it has already been pointed out, has a greater capacity for heat than any other substance. The same quantity of heat will not raise its temperature so high as it will that of other substances. Moreover radiant heat from the sun can penetrate to some depth into water, and thus the ocean, inland lakes, &c., can receive enormous quantities of heat, without their temperature being raised nearly to the same extent as land receiving equal quantities. These circumstances produce most marked modifying effects on the climate of localities by the sea, lake, or river. The surface of the sea being never heated by the sun's rays to the same extent as the surface of the land bordering it, the atmosphere in contact with the sea will be cooler than that in contact with the land, and thus a current will be established from sea to land—a sea breeze—which will keep the land cool. In the evening the land cools down much more rapidly than the sea, for the surface of the sea cannot, like the surface of the land, cool down more quickly than its deeper layers. As soon as the surface layer becomes cool it sinks, and is replaced by warmer water rising. The atmosphere over the land will, in consequence, become speedily colder than that over the sea, so that a land breeze will be created. In this case the warmer air from the sea will prevent the too rapid cooling of the general atmosphere. Thus during the day the climate will be less hot and during the night less cold than it would be, but for the modifying influences of the sea. Inland lakes have a similar effect though not nearly so marked, but when they are frozen over the influence ceases. In such circumstances as these, there is a period of the afternoon when the sea breeze begins to die down, because, owing to the setting sun, the land is less warmed and its air becomes more nearly like that of the sea in temperature. Between that period and the commencement of the land breeze, perhaps two or three hours later, when the earth has cooled sufficiently, there is a period of calm; and there is similarly a calm in the morning between the dying down of the land breeze and the setting in of that from the sea.

In another way does the presence of large masses of water influence the climate of a place. Wherever there is much water the air must contain a considerable degree of moisture because of evaporation from the surface, another agent in keeping down the temperature. Now while perfectly dry air will not absorb the solar rays as they pass through it—is transparent to heat, or diathermanous, as the correct word is—watery vapour does absorb heat to some extent. Moist air does, therefore, become warmer by the sun's rays passing through it, dry air does not. Moreover, when the heat is being given off from the earth at night, it will pass off much more rapidly if the air is dry and clear than if it is moist. There will, therefore, be less rapid cooling of the air at night in a locality where the air is moist to a greater or less degree. A moist atmosphere is heated to some degree not only by the sun's rays passing through it, but also to a considerable extent by rays reflected back into the atmosphere from the earth, for the earth does not retain or absorb all the rays that fall upon it. Now if the air were perfectly dry, these reflected rays would pass through the atmosphere without warming it, but when the air contains watery vapour, the watery particles absorb the reflected heat and thus retain, in the neighbourhood of the ground, heat, which would otherwise have been dissipated into space. The presence of clouds in the sky diminishes the loss of heat at night by radiating back to the earth the heat given off by it, and the lower the clouds are the more effective are they in maintaining the heat. It is this which explains the sultry oppressive feeling of the atmosphere on the evening of a hot summer day when the sky is dull.

Elevation above the Sea-level has a striking effect on the temperature of a place. As elevation increases, the temperature falls. The cause of this is mainly that the atmosphere is warmed by contact with the earth, and not by the direct action of the sun's rays. The higher the situation the more is the locality, in the cold regions of the atmosphere, removed from the warming influences of the earth's surface. At the same time the heating effect of the sun's direct rays becomes more perceptible in high situations, because the clearness of the air, and its freedom from fog and moisture, permit the full heat of the sun to play upon the body, &c., without let or hindrance. Thus, in high altitudes, in the sun one may be scorched, while in the shade one may be freezing. The more elevated the situation, then, the more is it deprived of such modifying influences as have been noted in preceding paragraphs, such as proximity to masses of water, watery vapour in the air, and so on. In consequence the variations of temperature are extreme and sudden. As a general rule the fall in temperature for increasing elevation is 1° Fahr. for each 300 feet of ascent. There is what at first sight looks like a very remarkable exception to this rule that temperature falls with increasing height, namely, that, at night, in calm dry clear weather, and in frosty weather, localities situated on a height are actually at a *higher* temperature than those in the valley. The reason of this is that, after sunset, the heat radiates rapidly from the earth, and the layer of air in contact with the chilled surface becomes in turn quickly cooled down. This cooled air being denser than the warmer air above it remains low-lying. In the case of hill slopes and valley, other circumstances being equal, the air in contact with the surface of the hillside will also be cooled down, and then owing to its increased density will flow down to fill the valley, while warmer air will supply its place on the slope. The cold of the night and of frost will, therefore, be felt less on the slope of the hill than at its foot. In the mind's eye one can picture, on a clear frosty night, the cold air currents flowing down the hillsides, like so many streams of water, into the valley, till the plain beneath is completely submerged beneath a sea of cold air, rising higher and higher, but above which the more elevated parts of the slope remain in warmer air. This is a point worth remembering in fixing upon a place of residence in an undulating country.

Prevailing Winds modify the temperature of localities very markedly. The warm westerly and south-westerly winds, for example, of our own climate, laden with moisture, raise the temperature of the western side of the British islands. If the winds blow from the direction of mountain ranges which are so high as to be perpetually capped with snow, they will depress the temperature; while if they come from the direction of hot, sandy deserts, they will raise the temperature. Winds blowing from the sea necessarily carry a considerable quantity of moisture, and this moist air, passing over a district exposed to the full blaze of a burning sun, will moderate the temperature of the place by the screen the watery vapour interposes in the path of the heat rays. On the other hand, passing over a cold region, the same moist wind will raise the temperature by diminishing the loss of heat by radiation from the surface of the earth, and by the deposition of its moisture liberating the heat which the water held in a latent condition while in a state of vapour. Moist ocean winds are, then, cooling in summer and warming in winter. On the other hand, dry winds blowing from continents raise the temperature in summer and lower it in winter.

The Position of Mountain Ranges, Hills, &c., is most important as an influence in determining the warmth of any particular locality. The hills may act as a barrier to cold winds. An excellent example of this is San Remo, the well-known Mediterranean health resort. Its prevailing winds are northerly, but it is guarded by a semicircle of mountains of the Maritime Alps. Though these ranges are interposed as a baffle-plate, as it were, between the cold north and north-east winds, which are thus deflected upwards, high over the sheltered piece of coastline, so that they never strike the town, they yet have an effect upon the temperature, preventing it becoming excessive. The situation of a locality in relation to mountain gorges, valleys, &c., is another illustration of the same fact. For example, there is a considerable difference in warmth between the eastern and western bays of Mentone, due to the fact that the mountain shelter of the eastern bay is complete, while, on the western bay, there are open valleys of the mountain range, down which the cold winds more readily sweep. Mountain ranges, hills, &c., may also serve to keep a locality cold if by their situation they screen it from the sun's rays.

The Influence of Ocean Currents in determining temperature is illustrated by the effect of the most important of such currents, that of the Gulf-stream, on the climate of Western Europe. "If no more heat is received than is due to the position of the globe in respect of latitude, the mean winter temperature of Shetland would be only 3° and that of London 17°. But, chiefly owing to the heat given out by the Gulf-stream during winter, and carried to these places by the winds, their winter temperatures are respectively 39° and 37°—Shetland being thus benefited 36° and London 20° from their proximity to the warm waters of the Atlantic. In Iceland and the Norwegian coast, the increase thus accruing to the winter temperature is much greater. To these places the Atlantic may be conceived as a vast repository of heat, in which the warmth of the summer months, and that of more southern regions, are treasured up and reserved against the rigours of winter" (Buchan). But for this stream the British climate would be fully 20° colder in winter than it is. "As regards their influence on climate," says Buchan, summarizing the results of Admiral Fitzroy's observations, "ocean currents raise the temperature of the west of Europe, the east of South America, the east of Africa, and the south of Asia; and depress the temperature on the east and west coasts of North America, the west coast of South America, the west coast of Africa, the east coast of Asia, and the south coast of Australia."

Other circumstances affect the temperature of a locality which it is scarcely necessary to consider at length. We may notice, for example, the form and colour of hills, cliffs, &c. The form of hills partially surrounding a locality may be such as to cause the sun's rays, reflected from them, to be concentrated on the place, and specially will this occur if white cliffs, rocks, &c., form part of the range, by which the reflection would be much greater.

The Meaning of Mean Temperature, &c. —There are certain technical expressions employed in describing the temperature of localities, which, in view of their subsequent use, it may be well to explain here. In the first place, the distinction between "heat in the sun," or "sun heat," and "heat in the shade," or "shade heat," should be noticed. The latter is the heat of the air, direct rays of the sun being prevented falling upon the thermometer, as well as rays reflected from any surface in its neighbourhood. The thermometer is usually exposed to the air in a louvre-boarded box, at a height of four feet from the ground, at a distance from walls or objects likely to be heated by the sun, and over old grass freely exposed during the day to the sun. The former expression, "sun heat," is applied to the heat obtained near the surface of the ground in such a position that the rays of the sun fall directly upon the bulb of the thermometer, which is coated with lampblack to enable it to absorb as much heat as possible.

The mean daily temperature is obtained by observing the temperature every hour, summing the results and dividing by 24, or by observing the highest temperature of the day, obtained by the maximum thermometer, and the lowest temperature of the day, obtained by the minimum thermometer, and taking their mean. The latter is now adopted and need imply only two daily observations, one at 9 a.m. and the second at 9 p.m. From these mean temperatures, the mean temperature of a week, a month, or a year may easily be calculated. The **mean annual temperature** is not of very high value in estimating the value of any locality as a health resort. Two places might have the same mean annual temperature, but that of one might be composed of a low winter temperature compensated for by a high degree of summer heat, while that of the other might be made up of a winter temperature not low and a summer temperature not high. The former climate would have extremes of heat and cold, the latter extremes of neither. For estimating the value of a climate for health purposes, then, it is best to obtain the mean temperatures for the seasons, spring, summer, &c., or still better the mean temperatures of the months. In the same way two places may show the same mean *daily* temperature, but one may enjoy a temperature which varies by only a few degrees in the twenty-four hours, while the other may have excessively hot days followed by very cold nights—made up of two extremes, that is to say. Obviously the former is more suitable from a health point of view. Therefore, to enable one to estimate the suitableness of a locality, one seeks to know not only the mean monthly or daily temperatures, but also the two elements which go to form the mean daily temperature, the highest and lowest temperature of the twenty-four hours. “Thus in the north-west parts of the United States of America the temperature in spring often rises to 83° during the day, and falls to freezing during the night.” This would give a mean temperature of 57°·5, which, it is apparent, if stated by itself would give an altogether erroneous impression.

The difference between the extreme day and night temperatures is called the **range of temperature**, and the less the range the more equable is the climate.

In this country temperature is stated according to **Fahrenheit's scale**—freezing point 32°, boiling point 212°. On the Continent the **Centigrade or Celsius' scale** is employed—freezing point 0°, boiling point 100°. It may be well to note how these may be converted, the one into the other. To convert Centigrade into Fahrenheit, multiply by 9, divide by 5, and add 32.

$$\text{Thus, } 100^\circ \text{ Centigrade} = \tfrac{900}{5} + 32 = 180 + 32 = 212^\circ \text{ Fahrenheit.}$$

To convert Fahrenheit into Centigrade, subtract 32, multiply the remainder by 5, and divide by 9.

$$\text{Thus, } 212^\circ \text{ Fahrenheit} = (212 - 32)\tfrac{5}{9} = 180\tfrac{5}{9} = \tfrac{900}{9} = 100^c \text{ Centigrade.}$$

Moisture of Air as it affects Climate.—Next to the temperature of the air, the amount of watery vapour the air contains is one of the most important circumstances affecting the climate of a locality. The difference between a dry climate and a humid climate is a difference only in degree, since all air contains some watery vapour. This has already been mentioned in discussing air on p. 682. It has been there explained that the capacity of air for absorbing moisture increases with its warmth. When air contains as much moisture as it can hold at a given temperature it is said to be saturated; and if the air then becomes cooled it must give up some of its moisture, which then becomes deposited in the form of dew, or falls as rain. Thus in the evening, when the sun has set, the heat rapidly passes off by radiation from the earth, and the surface of the ground becomes cooled. The air in contact with it, becoming thereby in turn cooler, is unable to retain all its moisture, and the excess is deposited as dew, the amount deposited being dependent on the amount of watery vapour in the air and the degree of cooling to which it is subject. The more rapidly, therefore, substances are cooled, the more speedily will dew be formed upon them, and the greater will be the amount deposited on them. Furs, wool, flax, silk, grass, and vegetable substances generally, cool more rapidly than gravel, stone, and sand, and on them more dew will appear. The cooling of the earth's surface is hindered by clouds, and the more effectually the lower the clouds are, for they radiate back to the earth the heat it gives off, so that a clear night is necessary for dew formation. Wind also hinders it, for it circulates the air and prevents the cold layer next the earth being formed. So also warm currents of air, laden with moisture, rising in the atmosphere and meeting with colder masses, are compelled to yield up a portion of their watery vapour, which then descends as rain or snow. Certain winds are, therefore, always accompanied by rain, since they bring with them, into colder latitudes, warmer moist currents, such as the south-west wind in our climate.

The air derives its moisture by evaporation as it passes over the surface of water and moist places. The warmer the wind is, the greater will be the amount of water picked up by it in its course. The actual amount of watery vapour held by a certain quantity of air is called its **absolute humidity**, but the quantity it holds in relation to the quantity it is capable of holding, at the given temperature, is called its **relative humidity**. Of two equal masses of air, both containing the same amount of watery vapour, but one of higher temperature than the other, the warmer will seem to be actually drier, because by its higher temperature it is capable of holding more water in the state of vapour than the other. It will not be so near its point of saturation as the colder mass of air; its relative humidity, that is to say, will be smaller. So that two masses of air may contain absolutely the same quantity of watery vapour, and yet one be called very damp and the other dry, because the former is colder than the latter. The relative humidity of air is expressed in terms of 100; that is, saturation is called 100; so that air whose humidity is 70 is $\frac{7}{10}$ths saturated. At sea, at night, the humidity of the air approaches saturation; in the interior of continents, amid dry sandy deserts, it falls very low. It is low at the hottest parts of the day and the hottest seasons of the year, and is high at night and in winter, in each case because of the temperature of the air.

The effects of the degree of humidity of the atmosphere on climate have already been alluded to in speaking of temperature. An atmosphere rich in moisture, however clear and transparent it may appear to the eye to be, greatly intercepts the radiant heat of the sun on its way to the earth. The watery vapour absorbs the radiant heat, so that less reaches the earth than would were the air more nearly dry. In the same way the heat of the earth is not given off so rapidly by night when the air is moist; its radiation is checked. Heat is thus more slowly acquired during the day and more slowly parted with during the night. This cooling influence by day and warming effect by night aid in minimizing sudden alternations of temperature, and help to secure a more equal distribution of heat during the twenty-four hours. This effect may, however, become excessive, so that the atmosphere is sultry and depressing and wanting in exhilarating character. But wherever the moisture is deficient, in countries exposed to the full blaze of the sun, the heat is burning throughout the day and the nights may be bitter with cold. "In mountainous countries where, on account of their height, much less aqueous vapour is interposed between them and the cold regions of space, radiation, both solar and terrestrial, is least obstructed. It is this which explains the scorching heat that surprises the Alpine tourist while travelling over fields of snow under a blazing noon-day sun. And it is the same cause, the small amount of vapour in the air, that explains the intense heat experienced in the direct rays of the sun in the polar regions."

Rainfall is a matter of great importance from the point of view of the person seeking a desirable climate. But amount of rainfall is not of so much value as an indication, as the record of the number of days on which the rain fell. Thus the rainfall may be enormous at one portion of the year, and much smaller during the remainder. At Madras, for example, the rainfall during the wet season, October, November, and December, is 30 inches, and for the other nine months of the year only 19 inches. At Gibraltar 33 inches fell in 26 hours, at Genoa 30 inches in 24 hours, and on the Khasia Hills, north-west of Calcutta, 30 inches fell on each of five successive days. This latter was due to the southerly winds, soaked with moisture from the Indian Ocean, being forced to yield up the water by the hills driving them up into the higher and colder regions of the air. For the chief determining causes of a rainfall are winds laden with moisture, from passing over a sea or ocean, being deflected upwards into the colder regions of the atmosphere by ranges of hills opposing their level course. These are the conditions on the west coasts of Great Britain, Ireland, France, Norway, Spain, and Portugal. The prevailing winds being south-west, they lick up moisture from the Atlantic, and the rainfall is, therefore, considerable in the immediate neighbourhood of high hills. On the other hand winds passing over sandy deserts, continents, &c., are dry.

The number of rainy days increases with the distance from the equator. In the northern hemisphere between 12° and 43° of latitude the average number of rainy days in the year is 78, while it is 103 between 43° and 46° of latitude, 134 between 46° and 50° latitude, and 161 beween 50° and 60° latitude.

Many other circumstances go to the determination of the characters of the climate of any locality—the prevailing winds and the exposure of the locality to them, or its protection by hills, liability to mists, fogs, &c., cultivation of the soil, drainage, &c., which need not be further considered.

Effects of Climate in Health.—The effects of excessive heat and cold upon health, from a climatic point of view, it is not possible to state with certainty, so much do other circumstances, such as those connected with food, exercise, humidity of the air, &c., influence the results. Tropical heat tends to raise the temperature of the body of those coming from temperate climates, but the increase does not exceed 2° Fahrenheit, and this is in time diminished by the increased action of the skin. This increased activity of the skin induces the eruption known as prickly heat, because of the great determination of blood to the skin rendered necessary. Breathing is affected, the respirations being lowered, and the total action of the lungs being diminished, so that less carbonic acid gas is given out. This is doubtless the result of lessened combustion going on in the body, since a much less production of heat in the body is called for, and of the rarefaction of the air causing less oxygen to be supplied from the atmosphere. The heart-beats are also diminished, it would appear. Corresponding to the diminished need of the internal production of heat, there is a lessened demand for food, less appetite, though an increased desire for water, because of the need of liquids to make good the evaporation from the surface. The digestive powers are also diminished, perhaps because of the determination of blood to the skin. In fact, general bodily and mental vigour is depressed in the case of persons belonging to a temperate climate proceeding to the tropics, though this is probably also a mixed result, dependent not only on the high temperature, but also on other conditions of the atmosphere, such as diminished oxygen, &c. It is generally believed that Europeans from temperate climates "do not flourish in countries much hotter, that is with a yearly mean of 20° Fahr. higher, as in many parts of India; that the race dwindles and finally dies out; and therefore that no acclimatisation of race occurs. And certainly it would appear that, in India, there is some evidence to show that the pure race, if not intermixed with the native, does not reach beyond the third generation. Yet it seems only right to say, that so many circumstances besides heat and the other elements of climate have been acting on the English race in India, that any conclusion opposed to acclimatisation must be considered as based on scanty evidence. We have not gauged on a large scale the effects of climate pure and simple, uncomplicated with malaria, bad diet, and other influences adverse to health and longevity" (Parkes). It is quite certain that the evil effects, ascribed so exclusively to the excessive degree of heat, have been largely due to the continuance of food, stimulants, and clothing, suited to temperate regions, but not adapted to the hot climate. A distinction is to be made between the heat due to the direct rays of the sun, **the heat in the sun**, and the heat of the atmosphere itself, **heat in the shade**. The latter is much less easily borne, because the hot air contains usually moisture, and the same degree of evaporation from the skin is not possible. Thus a sun heat of 120° can be endured when a shade heat of 90° to 100° is overpowering.

More moderate degrees of heat than that obtaining in tropical countries have similar effects in stimulating the skin and in diminishing appetite, respiration, and tissue change, but to a lessened extent. Persons who seek warmer climates, on account of weak health, do not usually seek warmth merely, do not seek, that is to say, simply to avoid cold, but also to avoid exposure to great variations in temperature; they seek to obtain a more uniform climate, to get rid of very pronounced currents of air which sudden changes of heat produce. It is to be noticed also that persons of weak general health require moderate degrees of heat to maintain the normal functions of body and mind, and that in their case the change to a warm climate is accompanied by a stimulus to the processes of life instead of a depression. In such persons the vital powers are already so depressed, that a degree of cold, which would exert only a quickening influence on the healthy body, almost paralyses them.

As to the effect of cold, it in general acts, on the healthy body, in a manner the reverse of heat, quickening the circulation, quickening digestion, improving the appetite, and accelerating tissue change. Provided appropriate food be forthcoming, all this is beneficial. By the healthy and vigorous, excessive cold is quite easily borne, being met by proper food and clothing. Supplied with these, the European, going from a temperate climate to the Arctic regions, can endure the cold and maintain his bodily warmth, while in a hot climate no device may enable him to keep cool. It is, of course, different with the delicate, in whom the diminished activity of the skin, by leading to the withdrawal of the blood to the deeper organs, is apt to occasion or maintain diseased states of lungs, kidneys, &c.

The effect of the degree of humidity of the air in health depends on the increased evaporating power of dry air and the diminished power of moist air. A dry air will encourage evaporation from the skin and lungs. But the air may be so dry, as in the case of the dry sirocco, that this becomes excessive, leading to harshness and dryness of the skin. The evaporating power, it is to be remembered, is to be considered not only in relation to the amount of moisture in the air but also to the temperature of the air, for a dry cold air will not absorb so much moisture as a dry warm air. In dry warm air the skin is specially stirred to activity, because of the flow of blood to it, to yield fluid for evaporation for maintaining the bodily heat at its proper level. When the dry air is cold, the skin is not so excited, since the blood is directed from the skin to the deep organs to prevent loss of heat from the surface, and it is the lungs which feel the stimulus. When the air is moist, on the other hand, the exhalation from both lungs and skin is lessened and a soothing rather than a stimulating influence is produced. When the air, in addition to being moist is warm, depression of the vital processes is the result, and oppression may be the result of the difficulty encountered by the skin of maintaining the balance of bodily temperature. Moist heat is one of the favourable conditions for the growth of putrefactive and other germs. In such circumstances diseases such as cholera, typhoid fever, diarrhœas, consumption, flourish. But when the air is at once moist and cold, chilling of the surface of the body results, because of the moisture aiding the conduction of heat from the body. Colds and rheumatic affections are likely to arise, and catarrhal states of the air-passages, such as bronchitis, and of the kidneys, are often induced.

Winds are to be counted as beneficial or injurious to health according to their characters, moisture, and so on, and their force. Complete absence of wind is not healthy, since the absence of atmospheric currents means the want of due admixture of the air, specially necessary in populated places. High winds, whether hot or cold, dry or moist, are injurious to health. In Great Britain the east winds of winter and spring, from their dry and piercing character, are powerful agents in raising the mortality.

As regards the pressure of the atmosphere, changes in it and their effects on health have been already referred to on p. 680.

The Effects of Climate in Disease will be seen, from what has been said, to be a very mixed problem. It is not a mere question of removing an invalid from a place of low to one of higher temperature, or the reverse; a great many other factors enter into the question. The effects of heat, as we have seen, cannot be dissociated from the effects of atmospheric moisture, nor can these be considered apart from the effects of atmospheric pressure as it affects, among other things, the quantity of oxygen in the air. Then one cannot afford to overlook the fact of the presence or absence of foreign materials in the air, such as dust raised by winds, materials due to industries of the district, and, of still more importance, foreign particles of organized kind such as depend upon the proximity of marshes, the drainage of the soil, the nature of the vegetation, the character and habits of life of those native to the locality. Still further, in considering the effects of climate in the treatment of disease, one must not overlook the facilities afforded by various localities, or the reverse, for exercise, the probabilities of a great deal of outdoor life being possible because of equability of climate, and freedom from violent winds and sudden surprises by variation of temperature or rapid alternation of sunshine and rain. Not only must the possibilities of exercise be taken into account, but also inducements to exercise, because of the natural beauties of the locality or artificially created attractions. Finally, before any invalid decides upon a climate where he may hopefully seek restored health and renewed vigour, the possibility of adequate and suitable accommodation being readily obtained, with safety from risk of encountering other diseases, must be settled. The drainage and water-supply of many health resorts were for a long time of so primitive a description, and the conditions of life of the inhabitants so careless of sanitary laws, that the seeker after health too often found disease, of a more serious and debilitating character than that from which he sought relief. Happily so much public attention has of recent years been directed to these subjects that such risks are much less than they used to be, especially in the case of the most favoured health resorts. So complicated then is the influence which the climate of any particular place may have on a person suffering from ill-health, and so greatly will the total effect depend upon the actual condition of the patient at the time, that it is very often impossible to predict very exactly what kind of climate will suit him, so that he may be compelled to try one locality after another before finding that which he seeks. Moreover the climate suitable for a patient in one phase of a disease may prove very unsuitable at another. How often does a person, suffering from some chronic disease, who is in the habit of regularly visiting some particular health resort and always with benefit, suddenly at some subsequent visit find that he is no longer benefited, and that he must set out again in quest of a more congenial climate.

If then we proceed to consider what are the general requirements in the way of climate that seem indicated in the chief of the ailments for which change is sought, and the principal places where they are to be found, it must be understood that no absolute statement can be made, and that each invalid can have the question of climate settled for him only by a very careful study of his own condition and all that it seems to demand. We shall begin such consideration of climate, as suited to particular diseases, by taking that class of diseases which provides probably the greatest number of those who seek change, namely sufferers from diseases of the lungs and air-passages.

Climate suited for Diseases of Lungs and Air-passages.—No class of diseases exemplifies more fully the truth of what has been said regarding the difficulty of settling the question of suitable climate than this class. The requirements for such diseases are a pure air, a temperature not subject to great or sudden alternations, abundance of sunshine, plentiful opportunities for exercise, but whether it should be moist or dry, bracing and stimulating or soothing, depends upon the nature of each case.

For Consumption of the Lungs a great variety of climate has been recommended. Dr. C. T. Williams, a high authority on the subject, gives the following statistics of consumptives who passed one or more winters out of England with their results:—

		Percentages.	
		Much Improved and Improved.	Worse.
Sea voyages to Australia, America, India, China, the Cape and West Indies	45 winters	89	5·5
Very dry climates; Egypt and Syria	26 ,,	65	10
,, ,, Cape and Natal	13 ,,	58·6	17·24
South of Europe and Mediterranean Basin, &c.	152 patients	62·5	17·1
Rome	18 ,,	55·56	33·33
Warm Atlantic Islands, Madeira, Teneriffe, St. Helena, West Indies	70 ,,	51·43	34·29
Calm moist inland temperate climate, Pau, Bagnères de Bigorre..	44 ,,	50	45·45.

In this table the highest place is assigned to sea voyages, and the next to *dry* climates. Moist warm climates are the least beneficial, if not on the whole actually injurious. The cases most suitable for a sea voyage are those in which the disease is in its early stage, and it is the most appropriate means of treating the disease when it is but suspected, when the tendency exists, and when the desire is to guard against it if possible. The best route is that to Australia, when the voyage lasts ninety days, which allows time for the patient getting rid of any preliminary sea-sickness and becoming used to the life of ship-board. If, however, there is risk of protracted sea-sickness, it would be an indication against the voyage. The beginning of October is the time to set sail, Australia being reached early in January, and the return voyage should be begun not later than the close of February. The interval should be spent in the table-land of New South Wales, or in Queensland, or New Zealand, or in cruising, residence in the coast towns being avoided on account of the heat. The return may be made by the Suez Canal or Cape of Good Hope.

Dry *inland* climates like those of Egypt and South Africa are preferred where the marine stations prove too stimulating, and tend to produce undue excitement. The Mediterranean health resorts, such as those of the Riviera, Mentone, San Remo, Cannes, Nice, specially the two former, and Algiers, are at once dry and stimulating, and are suitable for a large number of respiratory affections. But acute cases ought not to be sent thither.

British patients, who can meet the moderate expense of change of air to a not too distant locality, but whose resources would be taxed by so far a journey as the Mediterranean, or whose strength seems scarcely adequate to the travelling, will find Ventnor, in the Isle of Wight, and other stations in the south and south-west of England, such as Hastings and Bournemouth, very suitable. These localities, according to Dr. Williams, are to be preferred to Torquay and Penzance. Regarding Ventnor, Dr. Hill Hassall has supplied some instructive statistics, derived from the reports of the Hospital for Consumption and Diseases of the Chest, established by him there. In the four years 1870 to 1873, 474 patients were treated, of whom 122 were improved, 161 much improved, 83 very much improved; 28 were restored; 34 were in much the same condition as when they entered; 22 became worse; and only 24 died. In 1878, of 501 patients admitted during the year, 106 were improved; 78 became much better, 150 very much better; 53 were restored; 36 remained in much the same condition; 62 became worse, and only 16 died.

The treatment of consumption by a residence in mountain climates has of recent years been brought prominently before the medical profession. While safety from consumption is nowhere absolute, certain striking facts have been brought forward regarding the mortality from consumption among Swiss natives living regularly at certain levels. Thus in the case of those living at a level of from 1250 to 1650 feet above the sea, consumption was the cause of 10·2 per cent of the total deaths. The mortality at a height of from 1725 to 2700 feet was, from the same cause, 9·4 per cent. In the high regions, 2700 to 4000 feet, the mortality fell to 5·1 per cent, while above 5000 feet the disease totally disappears. In the Upper Engadine (5000 to 6000 feet), and at Davos Platz, consumption is said to be unknown among those who have always lived there. "Above a height of 8000 feet, in the Peruvian Andes, phthisis (consumption) is almost unknown among natives; while in the coast lands in the same country it is common and rapidly fatal." Now in these high altitudes it is not warmth that is sought, for in the health resorts of the Alps the temperature is low, and the season is in winter, from the middle of October to the end of March, the snow lying on the ground to a depth of 2 or 3 feet throughout that period. Still, in the direct rays of the sun, it is sometimes as warm as the midsummer of temperate climates. But the air is, if cold, very dry, and not liable to fluctuation; the sky is clear; and, owing to the bright sunshine, patients can be out of doors for most of the day, as they could not be in lower localities. The low temperature of the air, unfavourable as it is to putrefaction and to the propagation of the life of minute organisms, has probably something to do with the healthy influence. Undoubtedly another element in the beneficial effect is the low atmospheric pressure and consequent diminished density of the air. The effect of this is to produce expansion of the chest with accompanying expansion of the lungs. The effect of the climate of such altitudes is stimulating, both on heart and lungs, and also on the digestive organs; and there is consequent general improvement of nutrition. Nevertheless, all cases of consumption are not suited for such climates. Many could not bear the stimulating action of the high mountain air. The proper cases are specially those in the early stage, or those in a later stage, but not acute, where the disease is not extensive, and the patients have a good circulation and are able for a fair amount of exercise. Where there is risk of bleeding from the lungs the case is not suitable. In suitable cases complete arrest of the disease is often obtained.

The chief mountain resorts at present are the Swiss Alps, specially Davos Platz, 5140 feet above the sea-level, the Peruvian Andes, Santa Fé de Bogota, in New Granada, 8648 feet, a climate remarkable for equability, being 59° Fahr. in winter and 49°·5 in summer, Manitou Springs (6315 feet), Colorado Springs (5775 feet), and Denver (about 5000 feet), in the Rocky Mountains.

In regard to a summer health resort, the following are the conditions most suitable for the majority of consumptive cases, as stated by Dr. Hill Hassall: "The air should be dry, cool, moderately equable, but not cold; and the difference between day and night temperature should not be too considerable; the situation should be sunny, the sun neither reaching it too late in the day nor leaving it too early, as is the case with many of the mountain health resorts now in fashion; the elevation should not be too great, two, three, or at the most four thousand feet. I have known persons who have been sent to the Engadine suffer greatly in their breathing, even in summer, from the rarefaction of the air at that elevation, the difficulty being further increased by the great difference between the day and night temperature, and the cold of the early morning and afternoon as contrasted with the almost tropical midday heat."

In the lung condition known as emphysema (see p. 283) mountain climates are not to be recommended, but a mild not too dry resort, if possible in the neighbourhood of pine-woods. Arcachon, on the west coast of France, is recommended.

Bronchitis and other catarrhal affections of the respiratory organs, throat affections, &c., require climates similar to those already described for consumption, with the exception of those of high altitude. To those already named Hyères, in the south of France, may be added, and Arcachon, which lies south-west of Bordeaux. For chronic bronchitis, with much expectoration, dry climates are more suitable, while where the air-passages are irritable, and the expectoration is slight, a more moist locality is desired. Of the latter class Madeira may be taken as typical, which is noted for its soothing effect in irritable cough, allaying it in a very remarkable manner. In relaxed conditions of the system, however, with copious discharge, it is the reverse of suitable. The Azores and the Canary Islands are suitable in cases for which Madeira is. Teneriffe is the principal island of the latter group, and Orotava, a town on its north-western side, is provided with better accommodation than the capital, Santa Cruz. They are winter resorts; but at Orotava higher elevations are accessible, where in summer the excessive heat may be avoided. The English watering-places, Hastings, Ventnor, Torquay, may also be found useful.

Asthma.—The sufferer from asthma must in very many cases determine for himself what suits him best. Asthmatics are so commonly affected by the nature of the vegetation, that the patient is often driven from place to place, finding one place suit him at one season, and another at another season, according to the flowering time of certain plants. If the disease has been contracted in a moist climate, a dry one should be tried, and if it has been contracted inland, the sea-side may be resorted to. Mountain climates are very often useful; Madeira, and the Canary Islands, Pau, in the department of the Lower Pyrénées, and any of the climates already named as suitable for consumption may be found to yield benefit. In

Scotland, Forres, the hydropathic establishment of which is situated in the midst of a pine-wood, has a high repute for asthmatics.

The climate suited for heart affections is one rather bracing in character, moderately dry. Sudden changes of temperature, cold, and damp, are specially to be avoided. High altitudes are unsuited.

For diseases of the kidneys the climate must be warm and dry. The best for this purpose are Upper Egypt, Bombay, Cape of Good Hope, the Riviera, and in England Brighton, Folkestone, and Ventnor. Mountain climates are unsuited, and so are all moist climates. The latter diminish instead of stimulating the activity of the skin, and it is by the extra activity of the skin that the diseased organs are relieved. All cold and damp climates, by chilling the surface of the body and sending the blood to the deeper organs, are hurtful in such diseases.

Diseases of other abdominal organs will find suitable climate on the Mediterranean shore, or in the Lower Engadine, where Tarasp is specially recommended for the bilious and dyspeptic subject, the victim of chronic dysentery, or of nervous disorder consequent upon overwork. St. Moritz in the Upper Engadine is a favourite resort for sufferers from digestive derangements and sluggish circulation. For such disorders also the bracing influence of sea air is valuable, such as may be obtained in the health resorts of the south of England, Hastings, and Ventnor, or on the Irish coast, Queenstown. The association of baths and mineral waters with the climatic treatment is of great benefit in all disturbances of the abdominal organs, specially such as are attended by sluggish liver, constipation, &c., and the appropriate baths are noted in the part devoted to medicines. For feminine complaints the same thing is true.

The climate for malaria is that of high elevations, and bracing sea-side resorts, such as those of England.

The climate for nervous diseases varies according as the treatment indicated is of a stimulating or soothing character. Of the latter Arcachon in France is recommended for the calming and yet tonic action of the pine-woods, and dry inland climates, such as those of Upper Egypt, and the districts of Cannes away from the sea. Pau, in the Lower Pyrénées, is advantageous because of its calm atmosphere, which is very soothing to those of an irritable temperament, in whom nervous excitability is pronounced. Hyères is also advised in similar circumstances, Pisa in Tuscany, Venice, and Ischl in Austria. Biarritz, near Bayonne, on the west coast of France, is more bracing and exhilarating, being exposed to the winds and the influence of the Atlantic. Also, as a change from the more sedative climates, moderate mountain climates may be selected in summer. Nervous disorder, the result of overwork and worry, is best treated by a sea-voyage and the bracing influence of the sea-side resorts of temperate climates, such as the east coast of Scotland or the coasts of Ireland, or that of the island of Heligoland in the German Ocean.

The climate for scrofula ought to be one by the sea-shore, such as abound in the British Islands, the south and south-west in winter, and the east in summer; of the former Brighton, Isle of Wight, Bournemouth, and in Scotland Rothesay, and of the latter Scarborough, Lowestoft, the south coast of Fife in Scotland, or by Stonehaven in Aberdeenshire. Of the foreign resorts Algiers, Biarritz, Sicily are the chief.

In diseases of the general system and in convalescence from acute disease the Riviera is generally selected in winter and some more bracing mountain or sea air in summer. In England the health resorts of the south coast, and in Scotland Bridge of Allan, and Rothesay in Bute, are the winter resorts.

HEALTH RESORTS.

We shall now proceed to indicate a few of the chief features of some of the principal and best known health resorts, and any facts which may be of value to those in search of change of air and scene, in aiding their decision.

Various classifications have been proposed for climates. For instance one might divide climates into tropical, temperate, and arctic, a classification based on latitude. This would be of little use in indicating those suitable in the treatment of disease. Dr. Hermann Weber adopts two great divisions—Marine Climates (Island and Sea-coast), and Inland Climates. He classifies the former according as they are humid, or moderately humid, or dry, and the latter as mountain and lowland. Probably the purpose of those who consult this book will be best served if, without adopting any classification, we simply note various health resorts according to their geographical position, according to the country to which they belong.

British Health Resorts.

We have noted that the winter temperature of Great Britain is dependent upon the warmth brought to its shores by the Gulf-stream and the winds blowing from it. As might be expected it is the west coasts that benefit to the greatest degree by this influence. The lines of equal temperature run north and south, not across the islands, in winter, the temperature all along the east coast being 37°, while along the west coast it is 39° and 40° and rises to 42° and 43° in the south-west of England. "Since the temperature of the whole of the eastern slope of Great Britain is the same, it is evident that to those for whom a milder winter climate is required, a journey southward is followed by no practical advantage, unless directed to the west coast. And as the temperature on the west is uniform from Shetland to Wales, Scotland is as favourable to weak constitutions during winter as any part of England, except the south-west. The temperature on the south-west of England and Ireland being, however, 4° higher than the west of Scotland, the mildest climates, and therefore the most suitable resorts for invalids who require a mild climate, are to be found from the Isle of Wight westward, round the Cornish peninsula to the Bristol Channel, and from Carnsore Point in Ireland to Galway Bay" (Buchan). This region is characterized by its mild character and the shelter from the north and east, while its southern exposure and sea influence make it a very suitable region for winter resort.

The Isle of Wight is one of the most important of the winter health resorts in the region named. The Undercliff, on the south-east portion of the island, a landslip which forms a kind of terrace, about six miles long and half to three-quarters of a mile wide, is the chief part. It is protected from the north, north-east, north-west, west and south-west, by lofty downs of chalk and limestone, so that it is open directly only to the south, south-east, and obliquely to the south and south-west. In this district are **Bonchurch, Ventnor,** and **St. Lawrence.** "From and including Bonchurch, to the village of St. Lawrence beyond Ventnor, we have the most favoured and best protected portion of the Undercliff district, and the best adapted for the winter residence of the delicate; as we advance more to the west, the protection is less as a whole, though undoubtedly equal to that of the eastern Undercliff, in many of the sheltered little nooks. Moreover, owing to its elevation above the level of the sea, the Undercliff differs from most situations on our coast, in being less exposed to the direct and immediate influence of the sea-air" (Sir James Clark). Ventnor is built on a series of terraces, varying in elevation from 400 to 700 feet, and this affords a variety of climatic condition dependent upon the elevation. The mean winter temperature of the Undercliff is 42°·14, and the mean daily range 10°; the average annual rainfall is 26·23 inches, and the number of rainy days 144.

The climate is well suited for general conditions of ill-health, scrofula, anæmia, &c., in convalescence from acute disease, in chronic catarrh of the throat and upper air-passages, and in cases where the tendency to consumption is feared. The soil is dry, and the place has the great advantage of affording abundant space for out-door exercise, amid picturesque scenery.

Bournemouth, which is situated on a bay at the south-western extremity of Hampshire, is one of the most favoured of English health resorts. It is sheltered by extensive fir plantations, growing on surrounding slopes. The soil is sandy, and though this is of advantage by rapidly draining off surface water, in summer high winds blow clouds of it in a very disagreeable fashion. Its mean annual temperature is 49°·4, and it is blessed with a large amount of sunlight, and out-door exercise is agreeable. It is sheltered from the north, north-east, and partly from the east, but is less protected than the Undercliff and Torquay, though its temperature is somewhat lower than that of these places, while its atmosphere is less depressing. "There are two descriptions of persons to whom this climate offers great advantages," says Dr. Aitkin, "though neither may be said to labour under actual disease. In the first place, to persons who have long been resident in hot climates, and whose constitutions have, consequently, undergone changes that render them peculiarly susceptible of morbid impressions, resulting from the cold and dampness which prevail over by far the greater part of Great Britain. In the second place, to the young, who either from hereditary or accidental causes are of a weak habit of body, and whose tender and delicate constitutions, though unaffected with actual disease, yet are a constant source of apprehension and anxiety to their parents." It is a suitable place specially for delicate, sickly and rickety children, to whom its sands afford ample scope for amusement and exercise, while it is not unsuited for consumptive patients who are able to take a fair amount of exercise. The effect of the exhalations from its pine plantations is believed to be salutary in lung affections.

Weymouth, or **Melcombe Regis,** also with excellent sands and well protected by the bay,

Sidmouth, open to the south but sheltered from the north, north-west, east, and partially from the north-east, resembling Torquay, though somewhat colder, **Exmouth** and **Teignmouth**, are the chief places, as one travels westwards from Bournemouth till Torquay is reached. Sidmouth, Exmouth and Teignmouth are specially summer resorts, the last two being insufficiently sheltered, and not suited as climates for lung complaints during winter, because of this as well as because of a too variable temperature, while their bracing character makes them valuable resorts in summer. Exmouth consists of an old town, situated on a hill and exposed to high winds, and a new town more sheltered, but damp from its proximity to the river.

Torquay is celebrated for its mild climate and equable temperature. Situated on the north-east corner of Torbay, and surrounded by hills, which shelter it from north and north-west winds and in great measure also from north-east, and situated in one of the most beautiful districts of Devon, it presents to the invalid manifold attractions. Its mean winter temperature is 44°, higher, according to Mr. Vivian, than that of any other place in Great Britain; its annual rainfall is 28·2 inches, and the average annual number of rainy days 132. Its climate is not only warm and mild in comparison with many other places, but its characteristic is dryness, as compared with other parts of South Devon, supposed to be due to its position between two streams, the Dart and the Teign, which draw off the moisture, or to the limestone rocks, or the elevation of Dartmoor. The autumn and winter months are the least dry. The town is built on sites of varying elevation, the slopes being covered with villas, and thus, while the lower levels are mild and relaxing, more bracing atmosphere can be had within the limits of the town itself. It is a favourite place for persons suffering from general debility, for whom it is eminently suited, as a winter resort, and for consumptives, for whom, however, its moist air is scarcely to be commended if they can seek drier climates, though it is recommended in chronic bronchitis, pleurisy and asthma.

Dawlish, not far from Exmouth, is sheltered from the north and north-west, but open to the east, and is hence not a desirable place in spring.

Salcombe, further westwards than Torquay, is warm enough to permit the myrtle, lemon, orange, and aloe, to flourish naturally, and is said to be the warmest place on the south coast. It is, however, moist and relaxing, and the accommodation is restricted and room for exercise limited.

Penzance, on the shore of Mount's Bay, is the principal health station of the Land's End district. It faces the east, but is sheltered from western gales. It is 5° warmer in winter than London, and its temperature is equable, having a mean daily range of 6° as contrasted with 11° in London. Its winter temperature is less cold by many degrees than that of any other part of the kingdom, except Torquay, being 44°. The winter, however, if mild, is wet and the summer cool and moist, producing a feeling of languor and depression, so that its influence is decidedly sedative. The average rainfall is 44·66 inches, and the average annual number of rainy days 178. "In April and May it is decidedly inferior to the more sheltered spots on the south coast of Devon, and to the Undercliff" (Clark).

Falmouth, 30 miles eastwards, has a similar climate.

The Channel Islands possess a moist, equable climate, like that of the south-west coast of England generally. They are, however, exposed to high winds, and are subject in spring to the piercing north-east winds, so that they are rather summer than winter resorts. The climate is soothing and relaxing, as all warm moist climates are, and not suitable for patients who need a bracing air, such as those suffering from nervous or physical depression. Rheumatism prevails in Jersey.

The Scilly Islands, 42 miles from Penzance, and 25 from Land's End, possess the most equable winter temperature in the British Islands, if not in all Europe, according to Dr. Tripe. The mean temperature from November to March is 47°·9, but the moisture of the atmosphere is high.

Brighton, Eastbourne, St. Leonards and Hastings, on the south-east coast, are favourite summer resorts, as well as providing for suitable cases a winter climate.

Brighton extends along the coast for three miles, and its eastern and western portions differ considerably. The eastern portion is dry and bracing, the western more mild and damp. Sir James Clark says "delicate, nervous invalids generally feel better in the western part. Those, on the other hand, who suffer from a relaxed state of the system enjoy their health more fully in the eastern district. . . . Compared with other parts of the south coast, the climate of Brighton appears to the greatest advantage in the autumn and the early part of winter, when it is somewhat milder and more steady than that of Hastings. Accordingly in all cases in which a dry and mild air proves beneficial, Brighton, during this period of the year, deserves preference over every other part of this coast. In the spring, on the other hand, owing to its exposure to the north-easterly winds, the climate is cold, harsh, and irritating to delicate constitutions. At this season, therefore, sensitive invalids generally, and more especially persons with delicate chests, should avoid Brighton." In summer it is a most attractive sea-side resort. The summer season is from June to the middle of October. March, April, and May are the worst months for invalids, so that from October to March is the appropriate winter season.

Hastings and with it **St. Leonards** are suitable for the consumptive to an extent resembling the Undercliff of the Isle of Wight. They are sheltered by tall cliffs, 300 to 600 feet in height, from the north, north-east, and north-west, less so from the east, the exposure being thus south and south-west. Hastings is more soft and sheltered than St. Leonards. The lower parts of the town are more under shelter than the higher, and therefore warmer. From the beginning of November to the end of March is the appropriate season, during which the mean temperature is 41°·4. The soil is dry, sand overlying clay. Of Hastings Sir James Clark says: "As might be expected from its low and sheltered situation, it affords a favourable residence generally to invalids labouring under diseases of the chest; hence delicate persons, who require to avoid exposure to the north-east winds, may pass the cold season here with advantage. But in recommending Hastings as a residence in such cases, it will be necessary to take into consideration the full influence of the sea-air; for, owing to the close manner in which this place is hemmed in on the sea by steep and high cliffs, it has an atmosphere more completely marine than almost any other part of this coast, with the exception of St. Leonards. Judging from my own experience, I should say that the climate of Hastings is unfavourable in nervous complaints, more especially in nervous headaches, connected with, or entirely dependent upon, an irritable condition of the digestive organs, and also in cases where a disposition to apoplexy and epilepsy has been manifested. But it will be understood from what has been already stated respecting the topographical relations of Hastings, that this effect of its climate is chiefly experienced in the lower and more confined parts—nor is such an effect peculiar to this place, it is common, I believe, to all places similarly situated. The class of persons alluded to, if induced to reside for any length of time at Hastings, should avoid the more confined situations below the cliff, and rather seek such quarters as are more open and elevated, yet in some degree protected from north and north-east winds. These remarks on the climate of Hastings apply to it as a winter residence; as a summer residence the more open and exposed situations should be sought, and for many persons the high grounds behind Hastings would be preferable to the lower situations close to the shore." Dr. Hermann Weber says of it that as a winter climate it is less suitable for those requiring shelter, warmth, and a humid and equable atmosphere, but cases of atonic gout and rheumatism, and atonic catarrh of the mucous membranes, and tendency to colds from weakness, and atony (weakness) of the skin are generally benefited during the months of October to February. St. Leonards is not so warm for a winter residence; it is more blowy, more exposed to the east, less equable and more bracing. At both there is an excellent beach for sea-bathing, very bright, attractive, and bracing for children. Both places have the supreme advantage of offering to the visitor every kind of accommodation, convenience, amusement, and luxury.

The health stations situated farther to the east, **Hythe, Sandgate, Folkestone, Dover, Ramsgate, Margate,** are more suited for summer residences, and need not be considered here.

The east coast of England, like the east coast of Scotland, possesses many admirable watering-places, whose bracing tonic air is eminently fitted for the tired-out man of business or literary worker.

Yarmouth in Norfolk, **Lowestoft** in Suffolk, **Scarborough** and **Whitby, Redcar** and **Saltburn** in Yorkshire, are examples.

On the west coast of England **Bude,** on the north coast of Cornwall, **Barnstaple** and **Ilfracombe** on the North Devon coast, are examples of watering-places, not quite suited for winter residence for invalids because of their exposure, and not too bracing in summer.

The Welsh watering-places, **Aberystwith, Barmouth, Beaumaris** on Anglesea, and **Llandudno,** all partake of the same general characters, mild and humid, and they are all exposed to the westerly winds, except the last, which is sheltered by the Great Orme's Head from the west, north-west, and north, and by another and a lower range from the south and south-east. It is a possible health resort for those who can endure some amount of wind.

Southport, New Brighton, Blackpool, on the north-west coast of England, are excellent summer seaside resorts.

The Isle of Man, Dr. Weber says, deserves to be more appreciated. Its summer climate is more bracing than that of any locality near the western coast, and the sea-bathing is very good.

Scotland possesses two chief winter health resorts, Rothesay and Bridge of Allan.

Rothesay is situated on the Island of Bute, which is 18 miles long and 4 to 6 broad. It is surrounded on all sides by hills of the opposite coasts. Its temperature never falls low in winter nor rises high in summer, but its climate, though mild and equable, is very humid. It is excellently suited in the winter and spring months for the invalid who desires shelter from the cold of the season, but is not suffering from any particular disease; but it is too depressing and relaxing in summer for most people. "Every part of Bute is not equally mild during winter. The eastern is much milder than the northern coast, owing to its being in some measure protected from the influence of the north wind. The climate of this island may be styled as mild and equable, but rather humid. It resembles in character that of the south-west of England and France, and of the Channel Islands, though it is considerably less warm than any of these. As a winter residence for invalids it holds out considerable advantages to that class only for whom a soft, equable, but rather humid atmosphere, is indicated." Anyone with chest affections should not try it unless under medical advice. The accommodation and bathing facilities are all that could be wished.

Bridge of Allan, within a short distance of Stirling, is built on sloping ground well wooded, which protects it from the east wind. "From its sheltered position, the east wind passes over it at a reduced rate and force, and there being consequently less evaporation, our bodies are deprived of less heat, and thus the sensation of greater warmth which we feel is a reality. Again, being built on rising ground, the cold air flows down to the valley below it, so that excessive cold rarely occurs" (Buchan). The climate of Bridge of Allan is suited for the same class of cases as Rothesay.

If Scotland is poor in winter health resorts, "the whole land 'frae Maiden Kirk to John-o'-Groats,' is itself one great health resort for summer, when from early June to the late days of October, the stream of tourists pours unceasingly by glens and mountains, by lakes and rivers, such as few lands can excel for beauty." All along the east coast are to be found watering-places, unrivalled for their facilities for sea-bathing because of the long stretches of sandy shore, affording a bracing invigorating climate, though practically unsheltered from the winds. North Berwick on the southern shore of the Firth of Forth, Elie on the opposite coast, St. Andrews on the north-east coast of Fife, and the shores of Aberdeenshire are examples of seaside resorts of a stimulating and innerving character.

The west coast of Scotland is less bracing in summer, but is cooler and is more humid.

Of the health resorts of Ireland **Queenstown,** on the southern portion of the Island of Cove, in Cork Harbour, is suitable in winter under the same conditions that make the winter resorts of the southern coast of England advisable. It has a very mild and equable climate, has a southern exposure, but is sheltered from the north. Its mean winter temperature is 44°·21, and spring 50°·17. It is not suitable for anyone to whom a moist somewhat relaxing climate might prove injurious. In asthma and chronic bronchitis, with irritable cough, it has been recommended; but it is too moist, as a rule, for consumptive patients.

Glengariff, off Bantry Bay, is of similar characters and of much natural beauty.

In general it may be said of Irish as it is said of the most of the British seaside resorts that their equability of temperature, their relative warmth—a feature, as already pointed out, of all climates, whose dominating influence is the ocean—make them useful to those who do not require special protection; but that their high degree of moisture render them unsuitable in serious lung and kidney affections specially, as well as in rheumatic and gouty conditions. In scrofulous conditions, in convalescence from acute diseases and from surgical operations, and in persons in the enjoyment of fairly good constitutions, but suffering from overwork and strain, whether mental or physical, with fair digestive power and not liable to nervous irritability, they are to be recommended. The eastern coasts, it may be accepted as a general rule, are drier and colder, and the western warmer and more moist, but with a duller atmosphere. It is only on the western portion of the south coast of England that there are to be found climates with fairly dry atmosphere.

Another marked point of contrast between them and the health resorts of the Mediterranean, considered in the succeeding paragraphs, is the large number of rainy days they have annually, and the distribution of the rainfall throughout the whole year, so that days without rain cannot be reckoned on. Then the number of hours during which the rain continues on each day is more than in the more favoured southern climates. This is illustrated in the next paragraphs more fully.

Mediterranean Health Resorts.

The Western Riviera.—In the following paragraphs we shall consider very briefly only the best known of the health resorts of the northern shores of the Mediterranean. The chief of these are Hyères, Cannes, Nice, Monaco, Mentone, San Remo, the group which belongs to the district known as the Western Riviera.

The great characteristic of these localities is warmth accompanied by moderate dryness. They are more or less completely sheltered from northerly winds by the mountain chains of the Maritime Alps, though the different parts of the district vary in this respect, according to their proximity to gorges and valleys in the mountains, down which the cold winds may sweep. The soil is dry, the higher mountains being limestone. The mean annual temperature is about 60° Fahrenheit, Mentone being 60°·93, San Remo 60°·13, and Cannes 59°·9. Now that of the Undercliff, Isle of Wight, is nearly 9° less, and Bournemouth fully 11°. The mean winter temperature is 48°·98 in Mentone, 7° higher than that of the Undercliff. The thermometer rarely falls below 29° or 30° at night. The temperature in the sun is very great, but, notwithstanding, the daily range of temperature is comparatively small, being on a mean between 9° and 10°, for San Remo it is given as 9°·22. This is in consequence of three circumstances: first, the Mediterranean Sea, which equalizes the temperature, the explanation of which is given on p. 776; second, the sea breeze which prevails throughout the day, and thus cools the atmosphere at its hottest period; and third, the proximity of the mountains, which absorb the heat during the day, and radiate it at night upon the district, acting, as it has been said, like a warming plate to the shore. The number of sunny days is five times greater than in London. In Mentone, according to one authority, they averaged 214 in the year, 45·7 being partly sunshiny, 24·8 cloudy, and 80·8 rainy. Fog and mist are rare. The rain falls chiefly in September, October, and March. The number of rainy days per year of the chief resorts of the Riviera, and their contrast with other well-known places, are given by Dr. Hassall as follows:—

San Remo	48
Mentone	80
Nice	70 or 60
Cannes	70
Hyères	63
Pau	119
Malaga	40
Madeira	88
Ventnor	174·6
Bournemouth	156·3
Torquay	200

The atmospheric moisture is over 20 degrees less than in London, and it is the comparative dryness of the air that is one of the chief features of this district. The district is protected from the direct impact of the north winds by the mountain barrier. Nevertheless it is to their cold and dry characters that are attributed the clearness of the atmosphere and brilliance of sunshine. The wind which plagues these Mediterranean shores is the north-west or "Mistral." "It is a steady violent north-west wind which blows from France down on the Gulf of Lyons. It is immediately caused by the low atmospheric pressure in the Gulf of Lyons, as compared with the pressure to the north, and is most severe when at the same time very high pressures occur from France northwards towards the Arctic regions," which draw over the northern shores of the Mediterranean the polar current in its full strength, which becomes still colder and drier in crossing the Alps in its southward course. Such is Dr. Buchan's explanation. This wind is felt less at San Remo than at Cannes and Nice. While sheltered to the north, the Riviera is open to the south and south-west winds. It is to these that rain is due, bearing moisture as they do from the Atlantic as well as the Mediterranean. The south-east wind from the African deserts, as it strikes the southern coasts of Italy, is the Sirocco. Hot from the desert, but having swept up moisture from the sea, it comes as an exhausting wind. "It is the plague of the two Sicilies; and while it lasts, a haze obscures the atmosphere, and so great is the fatigue which it occasions that the streets of Palermo become quite deserted." Before it reaches the Riviera, however, it is cooled, and deprived of much of its evil influence, by the Italian mountains, but it is still felt sometimes as very warm and enervating. The mistral blows principally in March but occasionally also in winter and spring. The sirocco "blows only now and then for some days, and is then almost always followed by heavy rain." The north-east wind is felt at the Eastern Riviera more than at the Western and is cold and biting.

As regards the most suitable period of the year for this climate, we quote the following from Dr. Hassall, who takes San Remo as a type of the district, and speaks from his own experience: "First, I recommend the intending visitor not to delay his departure from England too long, lest he take cold and his health be injured, but to leave it by the 1st of October, even if he do not come straight to San Remo, but spend a few days on the way; reaching it not later than the middle of the month, by which time the autumnal rains will usually be over and a period of dry and fine weather be expected. With regard to departure, this should be postponed as long as possible, and it should certainly not take place earlier than the middle or better still the end of May. The weather during the spring and early summer is usually most beautiful and enjoyable, being by no means hot. It is in the spring months that the patient usually derives the greatest amount of benefit from his sojourn abroad; it is then that the weather becomes fine, bright and warm, and the days long, so that he can be constantly out of doors with advantage; it is then that all nature awakes with renewed life, and the earth, the hills and mountains become clothed with new beauties, imparting endless pleasure to the invalid in his walks and excursions."

It is also advised that the health seeker should not return directly home, but should spend not less than a month on the way, among Swiss resorts for example.

There are certain circumstances that must not be forgotten by the invalid at the Riviera, if he is to derive full benefit from his residence there. The temperature in the sun and that in the shade differ very considerably. The temperature in a room exposed to the north is during the day several degrees colder than one with a southern exposure, specially if the direct rays of the sun are beating upon the latter. For while the shade temperature during the winter months is 55°·9, that in the sun may be as high as 128°·9 Fahrenheit. Invalids may require then to take the precaution of having a room with a southern exposure in winter. Then with the setting of the sun the earth speedily begins to cool, and there is a sudden change in the temperature, and the nights are sometimes very cold. Exposure at night must, therefore, be avoided, the invalid systematically returning home sometime before sunset. In view also of sudden alternations of temperature during the day precautions should be taken. "Invalids should be warmly clad, wearing in fact very much the same winter clothes they would do if in England, the object being to keep themselves as far as possible comfortably warm, even to the hands and feet. It is very advisable that they should carry with them, when out of doors, an extra coat or shawl, which even in the house it is often requisite to wear. The San Remese, and indeed it may be said Italians on this coast generally, very commonly carry a second coat, in readiness to put on, should the weather become suddenly chilly; and it is by no means uncommon to see men wrapped up in shawls, much in the same way as women. It is impossible to be too careful in this respect." "Invalids, especially if suffering from chest affection, should not go out when the air is damp, when it rains, or when strong cold or damp winds are blowing. They should be most careful about sitting out of doors; they must only do so when the sun is shining and they are themselves placed in some warm and sheltered situation. If a suitable locality be chosen they can often bask in the sunshine during the winter for hours together. It is advisable always to be provided with a sunshade, as, if the powerful rays of the sun are allowed to fall directly on the head, they frequently give rise to troublesome headaches of a congestive character. Over-fatigue should be scrupulously avoided; no long excursions undertaken, and above all, if the lungs be affected, climbing up the hills and mountains should be absolutely forbidden. Much mischief occasionally ensues from a neglect of these precautions."

We conclude these considerations of the general features of this district, by noting what is the kind of disease for which the climate is most suitable. It is eminently suited for that class of invalids, who, without actual organic disease, are yet broken down in health from overwork or strain. The dryness which accompanies its warmth, as well as the effect of the sea air and the bright sunshine, make it tonic bracing and stimulating, just such qualities as are desired in the class of cases named. Digestion is improved; and the processes of tissue change and repair are quickened. The skin and circulation are also stimulated. Those same qualities indicate the benefits likely to be derived by those recovering from acute disease, by the aged and those too rapidly aging. Delicate children are also suitable patients, especially those constitutionally so, from scrofula or similar diseases of bad nutrition. Lung affections, of the consumptive kind, or of the bronchial variety, *if not acute*, are likely to improve with a sufficiently prolonged residence. But for some such cases the climate may be too bracing, for others, and this is more likely, it may not be sufficiently so. Each patient's own particular condition must be the indication of its suitability or otherwise. Consumption with a tendency to inflammatory action is deemed unsuited for treatment here, while the air is not sufficiently moist for nervous asthma. Digestive troubles, and disorders of the urinary and sexual organs may be aided in removal by the Riviera climate, but there are other much more suitable places, in which climatic treatment is combined with treatment by baths and mineral waters. It is not recommended in cases of heart disease nor for persons of a full habit of body, nor for those suffering from diseases of the nervous system.

We shall now note a few of the leading features of the chief resorts already discussed in their general features, noting any differences existing between them.

San Remo, situated on the Gulf of Genoa, is the typical place of the Riviera. Sixteen miles to the westwards is Mentone, 15 miles farther west is Nice, and Genoa is 85 miles farther east. It lies in a bay four miles broad, and is protected by an amphitheatre of mountain, rising gradually behind it from a height of 500 to nearly 4000 feet, the nearer ones being wooded with firs. East and west the promontories of the bay shelter it, and, unlike Mentone, it has within the circle of its hills no gorge or valley down which the north wind may sweep. It is more protected from the mistral than Cannes or towns farther to the west. The town contains 16,000 inhabitants. Corsica lies 80 miles to the south-east. The western part of the town stands on a higher elevation than the eastern and is nearer the sea, being consequently more bracing. Groves of olives shelter its lower levels. It is warmer than Nice or Cannes, though its annual temperature is slightly lower than that of Mentone, from which latter, however, it does not materially differ; while its rainy days, as shown on p. 790, are fewer. "Its climate," says Dr. Rose, "is intermediate between the east and west ends of Mentone, not so warm as the former and more sheltered than the latter, the air being also more soothing than at Cannes, Nice, and Mentone. This depends on the fact that the ground is covered to the water's edge with orange, lemon, and olive trees, thus preventing too rapid evaporation, and the soil, being principally clay, prevents the rain percolating through so rapidly as it would in sandy and gravelly soil." It has been noted that this soothing character of the San Remo air is in contrast with the more stimulating effects of the atmosphere of Nice, as shown by a tendency of the latter to produce sleeplessness, whereas in San Remo the air did not have this effect, "being tonic without being excitant, exhilarating and yet soothing." There is plenty of variety for walks and excursions, and the invalid who cannot venture far may exercise, sheltered by the orange groves.

Mentone, a town of 5000 inhabitants, is situated in the centre of a bay, about 4 miles wide, which is divided into an eastern and western portion by a projecting spur. The eastern portion is completely protected by the mountains which rise abruptly without break, and shelter it from the north, north-east, and north-west, while it is open to the south and south-east. The mountains behind the western portion are farther removed and are interrupted by valleys, through which the wind sometimes rushes with violence, and through which the mistral may find entrance, though modified by the mountains. The eastern bay is thus warmer than the western, but is rather restricted for exercise, while the western bay has plenty of space for exercise in parts well sheltered for the invalid. The difference of temperature between the two bays is so marked, that invalids residing in the eastern bay are advised not to pass the limits of that bay in the cold days of winter. Its mean winter temperature is between 48°·5 and 49°·5. The climate of Mentone "is warm, very dry, and stimulating; it is also very equable, being much less liable to sudden changes of temperature than Nice or Cannes. There is a want of circulation in the atmosphere, particularly in the eastern bay; and a close proximity of most of the houses to the sea subjects patients too much to the noise and stimulating effects of that element." But it is these qualities of the eastern bay that make it very suitable for some kinds of consumptive patients.

Monaco lies between Nice and Mentone, 10 miles from the former and 5 from the latter, on an elevated promontory. Just beyond it is the Casino of Monte Carlo. The lower town of Monaco is well protected on its westward side.

Nice is a town of over 40,000 inhabitants. It is not nearly so well protected by the Alps as any of the towns already named, because of its distance from them and their lower elevation. Of it Dr. Hassall says: "It is insufficiently protected by its beautiful encircling mountains, especially from the north-east and north-west winds; when these blow, the city is liable to sudden and great changes of temperature; changes which are somewhat dangerous even to those in health, and positively injurious to persons suffering from lung disease. Were Nice better protected from objectionable winds, the climate would be nearly equal to that of the most favoured of the health resorts of the Western Riviera. Like that of the Riviera generally, it is, even in winter, bright sunny dry and stimulating. The average annual temperature is 59°·48, and the three months' winter temperature 47°·82; it is, therefore, colder than either San Remo or Mentone; the rainfall amounts to 25 inches, and the number of rainy days according to De Valcourt to 70, being greater than all the other towns of the Riviera, with the exception of Mentone. Although, therefore, the climate of Nice is at times trying and treacherous, and hence unsuited to most invalids, there are yet some who derive benefit from its stimulating and bracing qualities; as those suffering from simple debility, atonic dyspepsia, and scrofulous affections. For some aged people it also affords a good winter retreat, provided they are on their guard and conform to the exigencies of the climate." And Dr. Walshe says that in no stage, in no degree, and in no form of tuberculization of the lungs, and no matter what be the temperament of the patient, is Nice proper a safe winter resort.

Cannes, strictly speaking, is beyond the limits of the Western Riviera. It is a town of about 14,000 inhabitants, situated on the Bay of Napoule, on its eastern side. Nice lies 19 miles to the east of it. It is sheltered on the west by the Esterel Mountains, while Cape Croisette protects it on the east, and on the north, north-east and north-west, it is sheltered by slopes of the Maritime Alps. They are, however, too distant and too low to make the shelter complete, and the north-west wind—the mistral—is a greater plague at Cannes than at the other chief towns of the Riviera. A thick yellow dust frequently covers the roads, and is lifted and driven in clouds by the wind. The old town is built on a ridge, Mont Chevalier, 147 feet high, which divides the bay into an eastern and western portion; the former is the smaller of the two and is more sheltered from the mistral. Its climate is dry, bracing, and stimulating, with a mean winter temperature—48° Fahr.—somewhat lower than San Remo or Mentone, while it largely exceeds these in the number of its rainy days (see p. 790) and the amount of its rainfall—25 inches. It is, therefore, not so well suited for those suffering from chest complaints. It has, however, advantages of its own in its less confined area, in the variety and beauty of its surroundings, and its absence of closeness. On the slope of the mountains, about 1000 feet high, and distant from Cannes 8 or 9 miles, is **Grasse**, with a southern exposure and fairly well sheltered, and famous for scent manufactories and for preserved and crystallized fruits; while north-east is the village of **Cannet**, famous for pottery-ware, whose air is more soothing in its influence than that of Cannes. Opposite Cannes, about a mile from the shore, are the islands of St. Marguerite and St. Honorat. Thus the surroundings of Cannes are varied and beautiful, and it affords a great variety of walks and excursions, a not unimportant matter in considering what is to be the winter residence of invalids.

Hyères lies still further west than Cannes. It is built on the slope of a range of hills, 60 feet above the sea-level, and is protected from north and north-east, but is open to the north-west wind. Its exposure is southern, and it is 3 miles inland. Its mean winter temperature is 47°·3; its average annual rainfall is 27 inches; and its number of rainy days 63. "The climate of Hyères is very good between November and the beginning of February, with many calm and sunny days; it ought to be avoided after this period by those who are unable to bear the mistral, or at all events the greatest care ought to be exercised. In April and May Hyères offers again more advantages. Many cases complicated with nervous irritability do much better here, because it is less under the direct influence of the sea than Nice and Mentone" (Weber). This lessened stimulating effect of the climate of Hyères, as compared with that of Cannes, Mentone, or Nice, is shown by the fact that patients driven from the latter towns by sleeplessness have slept soundly at Hyères.

Genoa lies at the eastern end of the Western Riviera. Its mean temperature is 46°·56, considerably lower than the more westerly towns, with more days of rain, more frequent visitation of frost, and above all with an exposure to the north and north-east. It cannot be counted, therefore, as a winter health resort for the invalid, nor is it suitable as a brief place of residence after a winter in milder climates. For those not strictly speaking invalid it has of course manifold attractions; and if its climate is not mild in comparison with San Remo it is yet bright and sunny.

Malaga, in Granada, on the south coast of Spain, 80 miles east of Gibraltar, is protected from the north and north-east by a range of mountains rising to a height of 3000 feet. It is, however, exposed to the north-west wind. Its winter temperature compares very favourably with those Mediterranean health resorts already named, being 54° to 55°, while that of San Remo is 48°·89, and its spring temperature 62°, while in San Remo it is 57°·32. The daily range of temperature is only 5°, the mean of that of San Remo being 9°·22. The air is drier than in the localities further east, and the number of rainy days is only 40, 8 less than at San Remo. February is the rainiest month. Its climate, which has been said to be the mildest climate in Europe, is warm, dry, equable, and bracing, but its exposure to the north-west wind, called here Terral, and which pours through gaps in the mountain chain and is laden with fine sand, is a bad feature. Invalids need to guard against the sudden fall of temperature after sunset, and the heavy dews. It is a suitable climate in the early stage of consumption, in chronic bronchitis with much expectoration, in bronchial asthma, and for children suffering from scrofulous affections. It is not advised for persons with nervous affections, or who are liable to apoplexy, or who suffer from neuralgia or chronic rheumatism.

Ajaccio, in Corsica, faces south-west, being sheltered from northerly winds. Its mean temperature in winter is about 54°, in spring 59°. The air is, however, moist, 80 per cent of saturation, and during the winter and spring the rainy days number 35.

Other Continental Resorts.

Pau is inland, situated in the south-west of France, in the department of the Basses-Pyrénées, 56 miles east-south-east of Bayonne. In a valley and surrounded by the mountains, its sheltered situation produces a very calm atmosphere. This renders it somewhat relaxing. Its mean temperature during the season—November to April—is about 48°·6, and the air is less dry, there are more rainy days—119—and a greater rainfall—43 in.—than in some of the chief places of the Riviera. The soothing influence of its climate is suitable in irritable conditions of the throat and air-passages, and in irritable conditions of the nervous system, and spasmodic asthma. Thus in chronic bronchitis with dry, worrying cough, it exerts a sedative effect. Rheumatism is said to be a common complaint among the native population. Occasional storms disturb the atmosphere, and in the later months of spring the weather is somewhat unsettled.

Biarritz lies on the coast of France within a few miles of the Spanish frontier, in the same department as Pau. It fronts the Atlantic and is quite unsheltered. It has therefore the characteristics of the most of seaside resorts open to the west. Its air is rather moist, and rain is apt to be frequent. But it has a dry soil. It is bracing; and is frequently resorted to in summer, but is suitable also in autumn and spring for those who seek a change without being actually invalids. "Persons disposed to hypochondriasis and mental depression, and many old Indians with their somewhat complicated cachexia, without organic disease, derive great benefit from the cheering influences of this climate, which is also a very good change from Pau and Arcachon." It is not, however, suited for cases of nervous irritability or a tendency to hysteria.

Arcachon, also on the west coast of France, is inland 9 miles. It is protected from the west and south-west, and also from the east and south-east, by the dense pine forest in which it lies. A large basin of sea-water, connected by means of a narrow channel with the Atlantic, diminishes the coldness and dryness of the north and north-east winds which reach it. Its mean annual temperature is 58°, and its moisture 15° short of saturation, its rainfall being 32 inches and rainy days 103. The soil is sandy and dry. "The climate is mild and soothing, and is specially suitable to cases of irritable bronchial or laryngeal catarrh, to cases of phthisis with tendency to congestion or inflammatory complications, and to persons of nervous temperament." To persons of a relaxed habit of body it is not to be recommended. The season is from October to May.

The coasts of Norway, Sweden, and Denmark, the coasts of Holland, Belgium, and Germany, and the shores of the Baltic, are all rich in seaside summer resorts, the features of which are a highly bracing, stimulating, and tonic climate, sea-bathing, and more or less natural beauties.

Alpine climates have of recent years become exceedingly popular especially for the treatment of lung affections. The atmospheric conditions in elevated situations have been already to some extent indicated in the early paragraphs of this section. The air is very pure, free to a very large, if not absolute, extent, of germ life, or if germ life is not absent the conditions are not favourable to its growth. This is a matter of very great moment in lung affections of a consumptive kind. Then the air is rarefied, because of the lower pressure; it is believed to be relatively drier; it is also colder, the degree of cold being dependent upon the elevation, but the heat of the sun is more intense. The effects of these conditions are experienced mainly by the heart, lungs, and skin. The action of the heart is increased, at first both in force and frequency, but latterly, as the person becomes accustomed to the elevation, the increased frequency disappears. The action of the lungs is also stimulated. The depth of breathing is increased, probably to compensate for the diminished amount of oxygen in the air, and the lungs are thus more fully expanded; the quantity of water and carbonic acid gas given out is increased. The digestion and appetite are improved; and on the skin a bracing and tonic effect is produced. Though the atmosphere is cold the tendency to take cold is lessened, perhaps because of the bracing effect of the cold on the skin, probably also because of the purity and relative dryness of the atmosphere. The whole effect is exhilarating, stimulating to improved general nutrition, which ought to be evidenced by gain of weight, increased elasticity of body and of muscular power. Perhaps the increased quantity of ozone in mountain air is a cause of the marked mental exhilaration. To the same cause has been attributed the sleeplessness which affects the majority of people at great elevations. The sleep is usually restless and filled with dreams for several nights after arrival. This, it is said, passes off at most in a week or two. But it has also been observed that less sleep seemed required, that a shorter than customary period seemed to suffice. On some people, however, mountain air has an effect conducive to sound sleep.

Mountain climates are eminently suited for conditions of depression due to mental or physical overstrain, with weak digestion, depressed nervous system, &c. For those recovering from acute disease, it is also advised as an active agent in quickening the process, and for those whose constitutions have been undermined by malaria, or by a residence in a hot climate, such as India. Chronic bronchitis with excessive expectoration may be expected to benefit, as well as cases of pure asthma, nervous asthma, particularly in the young or those not beyond the prime of life. Chronic catarrh of the throat and air-passages also yields to the bracing tonic influence of the mountain air, and relaxed conditions of the skin with excessive perspiration. The value of mountain climates for consumptive patients has of recent years been much discussed. Dr. Hermann Weber thus expresses his views:—"We cannot, therefore, hesitate to say that in a great many cases of phthisis and phthisical tendency, long residence in certain mountain climates is useful. Prominent among these conditions are: 1, tendency to phthisis, inherited or otherwise; 2, chronic catarrhal affections of the apex, or upper portion, of one or both lungs, without or with affection of the lung-tissue itself; 3, chronic bronchial catarrh of the lower lobes, with much secretion in young people, or, at all events, not in old people; 4, remains of pneumonia (inflammation of the lung); 5, remains of pleuritic affections, with and without exudation; 6, so-called caseous deposits, resulting from catarrhal, pneumonic, or pleuritic affections; 7, the early stages of phthisis in one or both lungs." "*We must add that phthisis, even in the earliest stages, ought to be excluded from European Alpine climates, when it occurs in persons with an irritable heart and circulation, with a constantly rapid pulse, whom the slightest derangement makes feverish, who are unable to bear cold and the slightest changes of temperature. . . . Further, patients with advanced and still progressive phthisis ought to avoid Alpine climates. It may be difficult to promise them a cure anywhere, but at the warmer health resorts of the Rivieras, Algiers, or Madeira, they have more comfort; while others, if they knew their condition, would prefer the sheltered localities near their own homes and friends. The same ought to be said to all those whose condition, if they were to go to the Alps, would be likely to keep them, during weeks and months together, indoors.*"

We have put these sentences in *italics* because many people cannot understand how a climate which has, without doubt, proved valuable in some cases of consumption, should not prove valuable to all, and because they emphasize the fact that it is in the early or only threatened stage of consumption that the climatic treatment ought to be resorted to. Many people when told they ought to leave business, professional duties, or household cares, for a change of air and scene, reply with the query, "Am I so bad as that?" Now it ought not to be when the patient has reached a grave stage in the course of a disease that he is ordered away, but more urgently as soon as risk seems to threaten, in order to prevent the arrival of a serious change. To the entreaty of the doctor, how often does the patient answer in effect, that he really cannot leave his work at present, that he will wait for a season, that there are no urgent symptoms, and that if urgent symptoms do show themselves, he will then be prepared to sacrifice everything and go off. It is, therefore, necessary to insist that the beneficial effects of all climatic treatment, most certainly in consumptive affections, and specially treatment by mountain air, are obtained chiefly in those periods when the disease is inactive, either before it has actually broken out, or when it seems to be quieting down after an outburst, one might almost say obtained *only* then.

The cases *not suitable* for mountain climates are those of heart disease, aneurism, tendency to apoplexy, dilatation of the lungs (emphysema, p. 283), tubercular disease of the larynx or bowel, tendency to acute rheumatism, or to acute inflammation of the throat and tonsils, convalescence from dysentery, Bright's disease of the kidneys, and the forms of consumption already indicated. Patients with irritability of the nervous system, as well as those who, from whatever cause, general debility, &c., cannot bear the sudden change from the heat of the direct rays of the sun during the day to the cold frosty air of the night, or who need protection from the wind, should not try mountain resorts. The old and the very young come into the last class. We shall now briefly note four of the chief Alpine health resorts; the mountain health resorts of America and India are illustrated under their respective headings.

Davos Platz is the chief mountain resort in Europe for consumptives. Attention was directed to it in 1867 by Dr. Weber, since which time it has achieved a great reputation. It is situated in the Canton Grisons, Switzerland, at an elevation of 5140 feet above the sea. Upwards of 1300 invalids winter there. It may be reached on the evening of the third day from London, the journey passing by Brussels, Basle, Zurich, and Ragatz, the distance from Ragatz to Davos being accomplished by diligence. It lies in a valley 4 miles long, running parallel to the Engadine but in an opposite direction. It is sheltered during the winter, and its atmosphere is still and cold.

The winter season lasts from the middle of October to the end of March. The snow falls early in November and lies crisp and clear till April, when it begins to melt, at which time visitors leave, though a mountain retreat is in summer as beneficial as in winter, for those who can bear the more changeable character of spring weather.

During the day patients go out into the sunshine; the treatment being essentially a pure air treatment, the more lengthened the outdoor life the better. From 10 a.m. to 4 p.m. the warm sunshine lasts; after the latter hour patients return indoors where a constant temperature of 65° is maintained. The temperature outside may fall to 10°, 20°, or more below freezing. This is not felt unduly, because of the purity, crispness, and comparative dryness of the air. From the Platz there is an ascent through pine-woods to the summit of a mountain 1000 feet higher, and this affords admirable exercise in easy stages for those who can attempt it wholly or partly. There is also abundance of amusement in the shape of concerts, &c., during the season. What has been said as to the cases for which mountain air is suitable is fully applicable to Davos Platz.

St. Moritz, another Swiss resort, is in the Upper Engadine, 5710 feet above the sea-level. There is more wind here than at Davos, and it is consequently less suited for those very sensitive to movement of the air. Its temperature is rather lower than that of Davos, but, with the exception noted, it is suitable for similar cases. It possesses an iron spring, and bathing and drinking houses. Its scenery is magnificent, and it affords greater scope for excursions. In winter there is the additional attraction of skating on the lake of St. Moritz. These circumstances, with the presence of the mineral spring, make it more advisable than Davos for those who do not require the more complete protection against wind offered by the latter. Business and professional men, the patient suffering from dyspepsia, sluggish liver, depressed nervous system, &c., will find it exceedingly attractive and bracing.

Tarasp, in the Lower Engadine, may be reached in one day from Davos or St. Moritz. Its altitude is barely 4000 feet. Eight hundred feet above it, reached by a winding path, is the village of **Vulpera**. It is a summer resort, the season being from June to the end of August. It is possessed of a Spa resembling that of the Carlsbad Sprüdel, the waters of which are drunk between 6 and 8 a.m., three tumblers being the rule, with an interval of twenty minutes' brisk walking exercise between each. It is not advised for consumptive patients, but for the dyspeptic, the victim of nervous depression and a slow liver, and the gouty.

Meran, in the Tyrol, may be reached from Tarasp in a journey by diligence of seventeen hours. It is well protected from the wind, lying sheltered in the Funster valley; and its winter climate is very equable. Its season begins in September. Consumptives resort to it for the "grape cure," which consists in consuming before breakfast three or four pounds of grapes. The patients, who employ the grapes, as others do waters elsewhere, for their action on the bowels, come out in the early morning (about 7·30) and slowly eat the grapes while quiet exercise is indulged in. A light breakfast follows. Consumptive patients are recommended to take the grapes after breakfast up till noon, and to eat them slowly, a pound being consumed. In this way they do not act upon the bowels as in the former.

Atlantic Islands Resorts.

Madeira is the type of warm and moist marine climates. The islands are situated in the North Atlantic, off the north-west coast of Africa, between 32° and 34° north latitude and 16° and 17° west longitude. Owing to the exceedingly equable character of the climate, Madeira was for a long time the chief resort of consumptives, but the moisture of the atmosphere has made it questionable whether it is really suitable for such cases. The chief place is Funchal. Its mean annual temperature is about 65°, the mean winter temperature being 61°, spring 62°, summer 69°·5, and autumn 67°. The lowest temperature is seldom below 48°, and the highest rarely above 86°, the range between day and night being about 9°. The degree of moisture is variable, between 70° and 74°, and the number of rainy days is 74. "Its rainfall in March is sometimes considerable, but from October to May you can always count upon an equable temperature, and weather at least as fine as a favourable June in England, and scenery which is among the most varied and attractive in the world." There are the daily sea and land breezes. The character of the climate is soothing and even relaxing. It is thus specially suitable for irritable conditions of the mucous membrane of the larynx and bronchial tubes, for chronic bronchitis with irritable cough and little expectoration, and for dilatation of the lungs. In early cases of consumption, in persons with excitable circulation, it deserves a trial.

The Canary Islands lie four degrees south of Madeira. The principal island is Teneriffe, extending 60 miles from north-east to south-west, 60 miles across at its widest part, and less than 16 miles at its narrowest, famous by its peak, which rises 12,000 feet above the sea-level. The capital is **Santa Cruz**, a town of 15,000 inhabitants, but its chief health resort is **Orotava** on the north-western side, reached from Santa Cruz by carriage in a few hours' drive. The town lies about 3 miles from the sea-coast and fully 1000 feet above its level, but the town of Port Orotava lies on a peninsula bathed by the Atlantic. The latter has become the most popular resort of recent years; and the following notes of the character of its climate are derived from letters written to the *British Medical Journal*, by the editor Mr. Ernest Hart, in 1887. The town lies on the brow of a hill, and behind it rise the mountain slopes of La Cumbra, "rising like scarped bastions to a height of 8000 feet."

The mean temperature of the year is 68°·5; between the hottest and the coldest month the temperature does not vary more than 14°, while in London it amounts to 26°·1, in Pau to 35°·8, in Madeira to 14°·9, in Algiers to 23°·5. The winter temperature is 63°·8, that of London is 41°·7, of Nice 49°·6, of Algiers 58°·3, of Madeira, 61°·7. "Moreover, it is not a mere lessening of the temperature, but quite another world. Neither at Nice, at Rome, at Naples, nor anywhere in France or Italy, can you dispense in the winter with fires at given periods of the day. I have felt it colder in going out after sunset along the Promenade des Anglais at Nice than almost anywhere else. I have shivered in a greatcoat in crossing the Libyan Desert in March, and twice I have passed through heavy hail-storms. On a dahabieh on the Nile ice will form on deck sometimes at night, so great is the fall of temperature after sunset. At Orotava, as Belcastel picturesquely puts it, a chimney would be ashamed of its perpetual nudity. There are none. Throughout the winter you bathe in the sea at Port Orotava, with as much pleasure as at Brighton in July." The extreme range of temperature during any one day during the six winter months does not exceed 5°·4, whereas even at Madeira it amounts to about 12°. "Orotava is not less remarkably favoured in respect to the singular dryness of the air, which makes it peculiarly valuable for a large class of invalids suffering from chest and throat affections, and in this respect it has an enormous advantage over Madeira. The rainfall at Madeira is estimated at 29 inches, that of Teneriffe amounts on the average to 14·7 inches, so that Orotava is twice as dry." The average relative humidity of the air varies from 53 in December to 79 in August. The refreshing land and sea breezes play with perfect regularity, the Peak of Teneriffe cutting off the north-east wind or brisa. "In short all the conditions present make the climate an ideal one both for lovers of health and lovers of Nature. Orotava has the exceptional advantage of being quite free from mosquitoes, which cannot be said of Las Palmas and Santa Cruz. In the Canaries generally there are no poisonous snakes or venomous reptiles." "From one year's end to the other the variation of temperature does not exceed 18°, and this within the limits which are most favourable to life. That is the whole magic of this climate. There is no excessive heat in summer; no cold in winter. Very small rainfall, and that chiefly at night. No chill at sunset; no heavy dews; no frosts; no sirocco. It is a climate full of geniality with neither bite nor burn. A garden of flowers which bloom perennially. It has the charm of temperate zones, without their fluctuations and their drawbacks; the delights of southern continents without their pests, such as mosquitoes, venomous beasts, and insects, their excessive heats, their miasms, or their heavy rainfall." "Medically Teneriffe is of course peculiarly suited to that important and numerous class of invalids who suffer from affections of the lungs and of the air passages," from consumption in various stages, Bright's disease and diabetes. Of it Professor Jaccoud says, "The climate of Teneriffe is drier and more tonic than that of Madeira, and it is capable of completing and usefully extending the therapeutic applications proper to Madeira in a number of cases. It unites the advantage of mild and equable temperature with those of proximity to the sea, and with the advantages of mountain climates." For in summer one may betake one's self inland and up the mountain slopes to the town of Orotava already mentioned, where the temperatures are slightly lower in winter, and perceptibly so in summer, but equally mild and equable. **Laguna**, on the road from Santa Cruz to Orotava, "offers a summer climate which leaves nothing to be desired," and affords to those who need it a more bracing air. "There are the capabilities of a high mountain station which would rival Davos, but they are not yet developed by suitable residences for invalids. Thus Teneriffe seems to possess all the resources which could be desired for residents throughout the year. Its capabilities as a summer resort still await further development, and I believe that it is intended to arrange hotel accommodation near La Paz, at Icod, and at Laguna, which will be a great boon to those who desire to spend the summer months in Teneriffe. Meantime there is no small number of houses to be had which were built by the vine-holders and cochineal-planters in the days when these agricultural industries were a source of great wealth, which they have now ceased to be. These houses, built in the Spanish style and suitable to the climate, may be rented at present (1887) at very low rates. I heard of rents of furnished villas varying from £2 a month up to £10 a month, the latter being the rent of a beautiful villa with a delightful garden. The wages of servants are very low indeed, and their diet is most frugal; so that, at the present scale of prices, permanent residence in Orotava is as cheap as it is delightful and healthful. I cannot but think that it is destined to become the most favoured health resort for Englishmen, and indeed for Europeans generally." It may finally be noted that difficulties which existed in getting to Orotava have now disappeared; that the passage may be made from Liverpool to Teneriffe and back by African lines of steamers for the sum of £15, which includes maintenance on board steamer on the most liberal scale for the eight days' journey out and the eight days' journey back; and at Orotava there is now excellent hotel accommodation.

It may be that, as indeed has been said, Mr. Ernest Hart has presented too roseate a view of the delights of the climate of Orotava. At any rate it has a rival in its immediate neighbourhood, namely Las Palmas.

Las Palmas is a town having a population of 12,572, situated on the Grand Canary, an island nearly circular in shape, of a diameter of 24 miles. It faces the Atlantic on the east, and behind it the island rises abruptly to a height of 250 to 300 feet, stretching out as a dry barren plain for about 2 miles. The nearest point of the African coast is distant 120 miles. It is said to be more interesting than Teneriffe, and for visitors it possesses the advantage of a fine sandy beach, 4 miles long, with abundant opportunities for bathing. The mean temperature of the six coldest months. November to May, is 63°·10, the mean of the highest is 68°·53, the mean of the lowest 57°·27, and the mean daily range 10°·86. The moisture of the atmosphere ranges from 54 to 70 per cent of saturation, and the annual rainfall amounts to 14 inches. "Las Palmas is favoured with a large amount of sunshine. The sun glows with great brilliancy, and pours down its life-giving rays through a sky of the most beautiful azure, making the air so luminous that everything looks bright and cheerful. Indeed all nature seems to rejoice in the sunny glory of Grand Canary, the most favoured of the 'Fortunate Islands.' The clear, pure, moderately dry air with which the 'gentle' trade-wind fans Las Palmas is very refreshing and invigorating." In summer the mountains offer a beautiful retreat from any undue heat. The climate is suited for consumptive cases, for chronic bronchitis, for diseases of the kidneys, for chronic rheumatism, and indeed for such cases as Orotava is suited for. "Although the daily range of temperature is slightly more than Madeira, this is more than compensated for by the tonic properties of the air, which is drier and bracing and illuminated by more brilliant sunshine. Las Palmas obviously possesses important climatic advantages over all of the famous health resorts of the south of Europe or the north of Africa. The invalid may be out in the open air all day long, and may sleep with his bed-room window wide open. Very rarely will he have occasion to remain indoors on account of rain." So writes Dr. Mordey Douglas, of Sunderland, who goes on to add, "During the seven months I was there I was only once prevented going out by rain. . . . Personally I have the greatest reason to be thankful that I sought the restorative influences of this splendid climate. I went branded with the ominous words 'no hope,' and have returned, as you see, a new man, with my health immensely improved. On the good opinion I formed of the climate of Las Palmas I did not hesitate to stake my life, and will do so again if necessary. And why should I hesitate, when after the most rigid and careful consideration I am forced to the conclusion that Las Palmas has the finest climate in the world of which we have any knowledge."

The Azores in Mid-Atlantic have a climate similar to Madeira.

African Health Resorts.

Algiers on the north coast of Africa has a climate of the general character of the districts on the Mediterranean shores, which sea is the chief influence in determining its exact nature. The mean temperature of the winter season, which extends from the end of October to the end of April, ranges between 57° and 62° Fahr., the daily range being about 12°, and during the same period the rainy days number between 45 and 65. It is exposed to the north-west wind, and suffers occasionally from the sirocco, hot and laden with sand from the desert, from which, however, the mountains afford considerable protection. The atmosphere is moderately humid. In early stages of consumption the climate is beneficial and in recovery from inflammation of the lungs. Bilious subjects do not benefit, nor is it suitable in Bright's disease. Sixty miles south-west of Algiers, 15 miles inland, and situated among the hills in the neighbourhood of pine-woods, are the hot springs of **Hammam R'Hira**. Here the air is drier and more stimulating, and moderately warm. October, November, and December are the best months, as towards the end of December, and in January, February, and March, it is rainy. Fair weather is again experienced in April and May. It is specially suitable for rheumatic and gouty patients. Hot saline baths are to be had and an iron spring for drinking.

Tangiers offers a delightful climate of the humid class, but mild and bright.

Egypt offers the most notable illustrations of a dry climate with heat. The air is dried by the desert, and owing to its clearness and freedom from moisture no screen is interposed to the rays from the sun. At sunset, however, radiation from the earth takes place rapidly and the nights are, consequently, very cold, with heavy dews. Thus while the mean temperature in December is 58°·5, the highest is 75° and the lowest 39°, showing an average range of temperature of 36°. The mean temperature for the four months December to March is 59°, and the mean daily range 40°. During these months the moisture of the atmosphere, as compared with June, July, and August in England, is as 56 to 81. Thus the marked feature of the climate is the dryness and clearness of the atmosphere, rain being practically unknown during the season. One notable effect of such a climate is its markedly stimulating action on the skin, the result of which is relief to deeper organs and specially the kidneys. In Bright's disease this climate offers benefits such as almost no other climate does; also in chronic rheumatism and gout and chronic catarrhal complaints, chronic bronchitis with excessive secretion. In early phthisis or in cases of consumption at other stages, but not active, the dry air of the desert is beneficial, and may arrest the progress of the disease.

Alexandria owing to its proximity to the sea has a moist atmosphere, which renders its climate uncomfortably hot, even when the temperature is not above 70° or 75°. **Cairo** is an improvement in this respect, but **Heluan**, 14 or 15 miles south of Cairo, Luxor, Assouan, and the Nubian Desert are the chief localities. Cairo has, of course, all the advantages of a town, and all its disadvantages of polluted atmosphere and insanitary conditions also. Heluan boasts a hotel and bath-house, and, in the desert, tent life is the rule. The Egyptian season begins with November and lasts till March, later than which the invalid must not stay. The return home should not be direct, but might be by the Grand Canary or Teneriffe, the higher stations being chosen for a brief residence.

South Africa possesses many health resorts, mountain as well as by the sea. Of the latter are **Capetown**, **Port-Elizabeth**, and **Port Natal.** **Capetown** has a mean winter temperature of 57°, spring and autumn 64°, summer 71°. Its characteristics are moderate dryness and warmth and the stimulating effect common to most coast places. Wind and dust are the drawbacks. In the interior the atmosphere is very dry.

In the interior **Bloemfontein** is the best-known place, being situated 4700 feet above sea-level, but **Pretoria**, **Heidelberg**, and many other places in the Transvaal are held in repute. The long journey by ox-wagon is the great objection to seeking these localities.

American Health Resorts.

It is not our object to do more than indicate a few of the leading features of some of the principal resorts in America recommended in recent years, and specially for those suffering from diseases of the lungs of a consumptive kind.

San Diego lies on the sea-board of California, fully 500 miles south of San Francisco, and just about the border of Lower California. It lies on a slope facing a bay, the bay of San Diego. The slope extends inland about a mile, gradually rising to a height of 200 feet, and is succeeded by a rolling table-land stretching for miles inland. The bay is formed into a natural harbour by a peninsula that stretches out a long protecting arm between it and the Pacific, the arm spreading out at its termination to an area on which is built the city of Coronado. At the end of 1887 the population of San Diego was 25,000; two years before it was not more than 4000. The people seem to be fully alive to the possible future of their city, and provision for effective drainage and water-supply has already been made.

As to the climate of San Diego, its mean summer temperature is 66°·7, the mean highest summer temperature is 88°·6, the mean of the lowest winter temperatures is 54°·4, the mean annual temperature being 60°·5. The relative humidity of the atmosphere is 72·9 per cent of saturation. Between the mean day temperature and that of the night in the month of January for twelve years the difference was only 13°, and the difference between the day and night temperatures for July was only 9°. The winter temperature never falls below 32°, and in ten years reached that point twice only. The atmosphere is rarely burdened with fogs, and blizzards are unknown, though hot dry winds from the desert blow occasionally, more frequently in winter. There are daily land and sea breezes, which blow for about three-fourths of the year with unfailing regularity, the remaining time being occupied by rain winds, which come from a southerly or south-westerly direction, and calms. "The great mountain range of California, the Sierra Nevada, practically terminates in San Diego County, while the foot-hills and elevated table-lands are continued into Lower California. The various peaks of Julian, Cuyamaca, Laguna, Palomar, Greyback, San Jacinto, &c., vary from 5000 to over 10,000 feet in height, and unite to make up the picturesque landscapes for which the county is so famous. These mountains are thickly wooded, and throughout the year covered with rich verdure, whose balsamic exudations from pine, hemlock, tamarack, &c., give a special character to the atmosphere. The climate is exceedingly dry and bracing, with an abundance of warm sunlight in winter and refreshing coolness in summer. . . . The highest elevations are seldom visited by invalids, inasmuch as the desired relief is generally obtained by a sojourn at lower levels. . . . During the summer, however, there is nothing so enjoyable as a trip to these mountains; and, as game is everywhere abundant, it is a paradise for hunters and camping parties."

The climate is suited for some classes of consumptives, for those suffering from malaria, for catarrhal conditions of the throat, nose, and air-passages, for asthma and hay-fever, a more or less dry air being obtained as the invalid retreats upwards and inland, or keeps near the coast-line. In summer the consumptive is advised not to remain below an altitude of 2000 feet, while in winter he may venture as far as the coast. In the valleys and in the elevated back country there are various small towns, such as San Jacinto, Elsinore and Linda Rosa, where hot sulphur bathing is to be had, so that the invalid has a choice of locality for his particular complaint.

San José is the principal town of Santa Clara County, California. It is 50 miles south of San Francisco, and with suburbs numbers 25,000 inhabitants. The western boundary of Santa Clara County lies 20 miles inland from the Pacific coast. "The county consists of a level valley varying in width from 6 to 18 miles, bounded on the north by the county of Alameda and Bay of San Francisco, extending south-easterly a distance of 50 miles and girt on either side by rolling hills and mountain ranges." The highest mountain summit, 4443 feet above sea-level, is Mount Hamilton, which is crowned by the Lick Observatory " with the largest telescope in the world." The mean temperature of this region is about 70° in summer and 55° in winter. In winter the lowest temperature is rarely below 30°, and this lasts only a brief period. "The average annual rainfall for twenty years was 16·17 inches. There is no rain during the summer, and the country after harvest, when the hills are brown and dusty, presents the most unprepossessing appearance." January and February are probably the best months, and in the hottest months of the year the mountains offer a refuge.

The climate, like that of San Diego, is equable and mild, with an atmosphere moderately humid and, therefore, resembling the warm moist climates of the Mediterranean.

Denver, Manitou Springs, and **Colorado Springs** in Colorado among the Rocky Mountains are the chief health resorts, at present, in America for the treatment of consumption.

Denver lies at an altitude of 5200 feet, and in 1880 had a population of over 30,000. Its situation is thus described by Dr. Denison:—"As seen across the plains from the city, the mountains, which residents of Denver and Colorado generally consider their own peculiar heritage, present a magnificent appearance. Apparently only 2 or 3 miles distant—owing to the wonderful clearness of the atmosphere—they are in reality 12 or 15 miles away, and seem to sweep around the city in the segment of a circle, in three tolerably distinct tiers, from Long's Peak, 50 miles north, to Pike's Peak, 80 miles south. The foot-hills, the first tier, rise two or three thousand feet above the plains, seamed with cañons and gorges, or dotted with sunny pastures; the second tier rises still higher, and more indistinct, while above all, the glistening peaks of the snowy range rise 13,000 or 14,000 feet into the intense blue sky."

Manitou Springs, Colorado, lies, at an elevation of 6370 feet, 75 miles south of Denver and 6 miles west of Colorado Springs, in a little valley sheltered on three sides by the hills. Running through the valley is Fountain Creek, upon the banks of which are the springs, six in number, on account of which the place is named. "Long before the medicinal virtues of the springs of this region were known to the white settlers, the Indians of the Rocky Mountain tribes were accustomed to bring hither their sick and afflicted to drink of and bathe in these waters, appropriately applying the name 'Manitou,' or 'Great Spirit,' to an agency of relief they deemed supernatural." These springs with their picturesque surroundings, and tonic atmosphere, yearly attract many invalids to Manitou, which is rapidly gaining favour, both as a summer and winter resort. In his *brochure* upon the mineral waters of this locality, Dr. S. E. Solly remarks: "The Manitou and Navajoe have been highly praised for their relief of old kidney and liver troubles, and the Iron Ute for chronic alcoholism and uterine derangements. Many of the phthisical patients who come to this dry bracing air, in increasing numbers, are also said to have drunk of the waters with evident advantage."

Colorado Springs is 6 miles from Manitou, and its altitude is 6000 feet.

The temperature, relative humidity, and rainfall in inches are shown in the following table:—

	Denver.	Manitou and Colorado Springs.
Mean Spring Temperature...... ..	47°	45°
,, Summer ,, ...	71°	68°
,, Autumn ,, ...	50°	48°
,, Winter ,, ...	29°	28°
,, Annual ,, ...	49°	47°
,, Relative Humidity (p. cent)	46	49
Yearly Mean Rainfall (in inches).	16	15

This table shows that at these resorts there is considerable variation of temperature at different seasons; and there is also a considerable difference between the sun and shade temperatures, and between day and night. This of necessity arises because of the great clearness of the air, permitting the sun's rays to be felt in full force during the day, and the absence of cloud permitting rapid loss of heat with sundown. In summer the neighbouring hills offer retreats from the excessive heat, camping out in tents being resorted to. The chief feature of the atmosphere is its dryness, and Dr. Denison concludes that *cool dry* climates are better adapted to the needs of consumptive patients than warm climates with moisture, or even warm dry climates, and it is to these features of the atmosphere of the Rocky Mountains that he assigns the curative influence. Asthma, inflammatory cases of consumption, and cases attended by bleeding from the lungs, in the early stage, are those which he believes to be best suited to such high altitudes; while those complicated with heart affection and chronic bronchitis he believes unsuited. Finally he concludes that "a somewhat *prolonged residence* is essential in the climate in which a certain consumptive finds his disease arrested; and a partial recovery generally necessitates a permanent residence, the return to the locality of the origination of the disease, except temporarily, being generally regarded as a dangerous procedure." Those who wish to study Dr. Denison's very full discussion of the subject will find it in his *Rocky Mountain Health Resorts*, published in 1880.

There are other resorts in America of a nature similar to those in Colorado, which cannot be discussed here, **Santa Fé**, 7000 feet above the sea-level, in New Mexico, and in South America among the Andes are similar resorts, such as **Santa Fé de Bogota** (8648 feet), **Quito** (10,000 feet), &c. The former has a remarkably equable temperature, 59° Fahr. in winter, and 59°·5 in spring and summer. Of the South American resorts, Dr. Weber says: "In no other climate have we witnessed such good results on our patients as in the Peruvian Andes; but the distance from home is great, and some invalids find it difficult to accustom themselves to Spanish, or rather Peruvian-Spanish, habits of life." He speaks specially in reference to **Jauja** and **Huancayo**, the health resorts for consumptive patients from Lima in Peru.

Florida as a health resort has come into prominence within the last ten or twelve years. The northern extremity of the state, bordering on Georgia and Alabama and forming the northeastern shore of the Gulf of Mexico, will naturally differ in climate from the middle division of the state, washed on the east by the Atlantic and on the west by the waters of the Gulf; and this middle division will again vary considerably from the extremity of the peninsula, not only because the latter is nearer the tropics, but also because round it sweeps the warm current of the Gulf-stream. The easterly winds, warm from the Gulf-stream, keep the eastern or Atlantic coast of Florida warmer by more than 1° than the Gulf coast, making the winter climate of the former milder and more equable than the latter. In the northern division the extremes of temperature are 105° and 20°, in the middle division—the Orange Belt—they are 100° and 25°, and in the extreme south 95° and 30°. These, it is to be noted, are *extremes*. In the middle division the climate is characterized by remarkable equability, freedom from sudden change and marked cold, and not subject to excessive heat. Frost sometimes occurs; when it does, great damage is done to orange culture, as in the cold snap of 1886. A remarkable feature of Florida is the enormous number of inland lakes, said to number certainly 1200 fresh-water lakes, the largest of which, Lake Okeechobee, has an area of 1000 square miles, and the smallest less than 100 square feet. Lake Okeechobee is at the northern border of the southern division of Florida, and south of it there extends an enormous tract of marsh, filled with islands, called the Everglades, or in Indian, "Grass Water." These Everglades cover an aggregate area of fully 7500 square miles; the water varies in depth from a few inches to several feet, rarely more than ten. "Tall grass, as high sometimes as 8 or 10 feet, is very common, with shrubs, vines, trees, moss, and all sorts of tangle and roots. Islands lie here and there, with trees and vines on them—cypress, pine, oaks, palmettoes, magnolias, and a score at least of other sub-tropical trees. Fish in infinite variety abound everywhere." The waters are not stagnant and foul, but clear and pure, and said to be even drinkable. In the rainy season, July to October, the Everglades are impassable. In 1881 a company began operations to reclaim by drainage this submerged land in the neighbourhood of Lake Okeechobee, already with considerable success. It is this enormous area of water-covered land, along with a coast-line of nearly 1200 miles, that is the main factor in producing the singularly equable climate.

One of the chief health resorts is **Jacksonville**, on the St. John's River, a few miles from the coast, not far from the northern boundary of the state. Its proximity to the Atlantic confers on it a climate characteristic of that of the mid or semi-tropical division of Florida. Its mean temperature for the year 1887 was 68°·1, the maximum 100°·3, and the minimum 21°·9. The mean winter temperature is said to be 60°, and the summer 80°, while the mean relative humidity for the five months, from November to March, is 68·8 per cent of saturation.

St. Augustine, on the coast, 36 miles south of Jacksonville, the oldest city in the United States, and "noted for its picturesque beauty," is a favonrite resort. **Key West**, on one of the multitudinous islands of the Florida Keys, the whole area of which is 12 square miles, is another of the favoured resorts. Its mean relative humidity for the months November to March is 76·8. On the Gulf coast from **Cedar Keys**, 127 miles south-west across the peninsula from Jacksonville, down southwards past Punta Rassa, on to Monroe County and the Ten Thousand Islands, is a coast-line offering a suitable climate for a winter health resort, though, as already stated, fully a degree lower in temperature than localities of a similar latitude on the Atlantic coast. **Punta Rassa** is 200 miles south of Cedar Keys and 100 north of Cape Sable. Its mean annual temperature is 73°·4. The lowest monthly mean temperature—that of December—is 64°·5, the highest monthly mean temperature—that of July—is 81°·3. Its mean relative humidity for the winter season—November to March—is 72·7 per cent. Along this coast there are numerous harbours, visited by coasting steamers, where accommodation for travellers is now being provided.

The mid division, then, of Florida is the one which offers the chief advantages to the traveller for pleasure and the seeker after health. As a winter climate it is remarkable for warmth, equability, and moderate dryness. The state of Florida is said to be the healthiest in the United States. The U.S. census reports give the deaths from consumption as equal to 58 out of 1000 from all causes, while in New York State the number is 168, in California 138, in Maine 258. As to malaria it is doubtless to be found in the marshes of the Everglades, but not upon the coast.

Florida offers a unique climate for the sufferer from general ill-health, who is still not the victim of any particular disease. Not only does its equable and moderately dry climate offer unusual opportunities for an out-of-door life, but its varied and luxuriant vegetation, the semi-tropical character of its scenery, its inland lakes, its coast-line, the antique aspect of some of its towns, all bring to the utmost that powerfully healthful influence to bear on the depressed spirit and broken-down nervous system, which is summed up in the phrase "change of scene." Sufferers from lung diseases and consumption are also sent there. It is suited to them, *if the disease is not advanced.* If they seek and are capable of an out-of-door life, free from sudden and extreme changes, where they may lead an existence not of chronic invalidism but of active work, it is a suitable climate. But patients ought not to be sent there as a last resort, nor in the desperate hope of arresting a disease already far advanced. The climate of Florida is indeed fitted for such cases as have been described as benefited by the Riviera resorts of the Mediterranean. While we have noted the kind of consumptive cases for which it is beneficial, we remark that it is yet probably excelled for such cases by the drier air of mountain resorts.

The Bahama Islands, or Lucayos, lie to the south-east of Florida, and are washed by the waters of the Gulf-stream. Of the twenty-nine islands New Providence is the most populous, and contains the capital, Nassau. The lowest mean monthly temperature—that of January—is 70°, and the highest—that of July—82°. Equability is therefore a notable feature of the climate. From November to April, the winter season, the climate is most agreeable, and the rainfall is small. The mean relative humidity for the five winter months is 73·2. New Providence was held in repute as a climate for consumptives, but lung affections are common among Africans and the coloured race, and among the black troops, stationed at Nassau, the proportion invalided from this disease was very high. Those for whom Madeira is recommended would probably find the Bahama Islands still better, because of their greater equability of temperature.

Bermudas or Somers Islands, situated in the Atlantic, 600 miles east by south of Cape Hatteras, are another winter resort for America. The mean temperature is 70°, maximum 85°·8, and minimum 49°. They afford, therefore, a warm, equable, marine climate. They have been subject, however, to four attacks of yellow fever in the last thirty years.

Indian Health Resorts.

The Hill Stations of India are resorted to as an escape from the exhausting influence of the heat and the malaria so common on less elevated ground. Of these stations Sir Joseph Fayrer speaks as follows: "In the absence of organic lesions in important organs, such as liver, alimentary canal, lungs and heart, &c., the tendency to recurrence of the periodic forms of fever caused by malaria is lessened or prevented by a sufficiently prolonged change to the hill sanitaria, whilst the whole system is remarkably reinvigorated. For such invalids and convalescents they are invaluable, though not quite equal to the more radical relaxation and change of climate involved by two long sea voyages with a more or less protracted sojourn in this country, or in some of the other salubrious localities of Europe. When, however, there has been developed any marked structural disease of the cerebral, thoracic, or abdominal organs, or even when, without any discovered or discoverable mischief of this nature to these parts, the blood, the digestive and nervous systems have become seriously impaired or damaged, experience has shown that removal to Europe is absolutely necessary to check the further downward progress and to secure convalescence. For such cases the hill climates are not suited. Moreover, it sometimes happens that invalids who have been weakened by heat and malarious fevers on the plains are liable to suffer from hill diarrhœa, especially at Simla, due probably to their previous enervated condition, diminution of air pressure, suppression of the action of the skin, bad water, and bad sanitation." Dr. Parkes believes it is because of the last two causes that such diarrhœa arises, and not simply because of the effect of the higher elevation, and specially because of unwholesome drinking-water. Among the stations named by Dr. Parkes are Darjeeling, Simla, Landour, Murree, Kussowlie, Nainee Tal, Dugshai, and Subathoo in the Bengal Presidency, the resorts of the Nilgherry range, Ootacamund, Wellington, Coonoor, Kotagiri in the Madras Presidency, and Mount Aboo, Mahableshwur, and Poorandhur in the Bombay Presidency. The first range from 4000 to 8000 feet above the sea-level, the second from 5000 to 7000 feet, and the third from 4000 to 4700 feet. If **Simla** be taken as an illustration, its lowest temperature is given by Parkes as 40° in the shade, and its highest as 80°, in June, with a total rainfall of 70 inches on an average. The fall is greatest in July and August, but from May to September the air is moist, and clouds and fogs are common. It is unsuited to the consumptive and to those with disease of heart or liver. Hill diarrhœa is common; and those liable to bowel complaint should seek some other station. It is believed to be free from malaria, and those weakened by such attacks, or in depressed health from overwork, &c., but otherwise sound, find it beneficial.

Murree, in the Punjaub, at an elevation of 7507 feet, has a temperature of 71° in June, the hottest month, and 36°·7 in January, the coldest, with an annual rainfall of 58·44 inches. It is well suited for Europeans who do not suffer from organic disease.

Landour and **Mussoorie**, in the North-west Provinces, the former over 8000 feet, and the latter nearly 7500, with a temperature of 70° to 74° in June, and 40° to 42° in January, the hottest and coldest months respectively, are also recommended as stations for those affected with malaria, and consequent disturbance of general health, but not where organic disease of heart, lungs, liver, or bowels exists.

Darjeeling, at an elevation of 6912 feet, situated in Sikkim, is said by Sir Joseph Fayrer to be, perhaps, the most salubrious of all the Himalayan sanitaria, and much of this is due to the comparative equability of its climate. Its highest mean temperature is in June, 63°·3, and its lowest in January, 39°·2; the rainfall is 118·24 annually. "Even very weakly children transported thither from the malarious plains soon become firm, plump, and rosy." In organic disease it is more beneficial than any of the other stations, though its chief benefits are derived by those suffering from functional disturbances only.

The **Nilgherry stations, Ootacamund** (7000 feet), **Coonoor** (6500 feet), **Wellington** (6200 feet), and **Kotagiri** (6500 feet) in the south-west of India, are called the Queen of Indian Sanitaria. Of them Fayrer says, "In the Nilgherries the invalid may exercise a choice of climate, not possible, in anything approaching an equal degree, at any of the other sanitaria brought under notice in this brief resumé. He may select Coonoor for its mildness, warmth, equability, and scenery, to prepare his constitution for the cooler and more bracing climate of Ootacamund; or, if his case indicate such necessity, he may remain there during his sojourn in the hills; or, to escape the south-west monsoon, its discomforts and disadvantages, he may find a pleasant and congenial refuge at Kotagiri, where its depressing influence is only experienced in a much mitigated degree. And when the north-east monsoon prevails at Kotagiri, from October to January, he may exchange residence there for Coonoor, where its force is only slightly experienced, or for Ootacamund, where it is not at all felt. The general experience of the many able physicians who have practised at these sanitaria tends to the conclusion that, whilst they are, at suitable seasons, particularly during the winter and hot months, eminently restorative in cases of ill-health, caused by the heat and malaria of the low country, exhaustion of nerve energy, indigestion, portal plethora, and malarial fever, uncomplicated with visceral disease of a serious character, they are not advantageous to those afflicted with liver disorder, dysentery, phthisis, cardiac (heart) and brain disease. To those of all ages already in possession of sound physical and mental health, the Nilgherries, whether for temporary or permanent residence, stand out conspicuously as the most salubrious of all the known mountain climates of India. The children of European parentage, who remain all the year round, during the period set apart for educational training, are remarkably robust and healthy."

Mahableshwur, at an elevation of over 4500 feet, in the Western Ghats mountains, south of Bombay, is the summer residence of the Bombay government. Its season is from October to June. Between June and September is its rainy season, when the climate is hurtful to cases of rheumatism and of organic affections of lungs, bowel, liver, and heart.

Mount Aboo in Rajputana has an elevation of nearly 4000 feet. Its lowest mean temperature is 54°·2 in January, and its highest 77°·9 in May. June to September are its rainiest months.

We quote from Sir Joseph Fayrer, one of the highest authorities on the climate of India, the following practical rules: "Those who select India for a career should be in the enjoyment of fairly good physical and mental health. . . . The European should, if possible, make arrangements to arrive in India, at or near the commencement of the cold weather, or, at any rate, before its termination—say in November, and not later than January. The trying heat of the Red Sea, during the outward journey, is thus reduced to a minimum; and the transition from the autumn or early winter of this country to the genial cold season in India is found to be pleasant and healthful, whilst time is allowed, as the hot weather gradually approaches, for the partial accommodation of the constitution to the altered circumstances involved in the transfer from a temperate to a tropical climate. If, however, this is impracticable, the second best season for arrival, at some parts, under the influence of the south-west monsoon, is during July and August. But, in the event of this period being fixed upon for the voyage, the utmost care, in diet, drink, and clothing, must be taken to neutralize or mitigate the heat of Egypt and the Red Sea. Under such conditions, precautions must be had recourse to, to avoid anything like constipation, whilst the strictest abstinence from too highly seasoned food and alcoholic liquors must be enjoined. To time the arrival in India in April, May, and June—the hottest months—or during the latter half of September and most of October—the malarious season—is often to sow the seeds of cerebral (brain) and hepatic (liver) disease, which may give considerable future trouble, embitter subsequent residence, and foster an ineradicable dislike to the country. No one in delicate health, or who is not strong and vigorous, should be advised, or permitted to select these months for the commencement, or continuation of an Indian career."

"May and June, the hottest months, are not suited for leaving India, although some still do so, at the beginning of the former month, because it enables them to arrive in England in summer. But to the strongest, the voyage at this season is very trying—often to those in infirm health, fatal, especially in the Red Sea. . . . The danger is immensely increased by intemperance in eating or drinking. So it is in a journey across India, and thence to this country, in May or June. The climate of India during November, December, and January is so agreeable and salubrious that few who can remain leave it during these months." "February and March are the best months for embarkation, from any of the three principal Indian ports, especially for invalids, ladies, and children. The railways and inland river steamers now render it possible to reach these places, with expedition and punctuality, from the most remote districts. With sufficient forethought as to clothing and provisions, the longest railway journeys may be undertaken at this season in comfort and safety. . . . On starting from India, provision should be made for abundance of the warmest woollen and other clothing, to be utilized in the Mediterranean perhaps, the Atlantic and the Channel. Too much care cannot be exercised in thus securing the invalid, as well as those who are apparently in excellent health, against the evil effects of chill. Yet such a simple and self-evident precaution is too often neglected, and bronchitis, congestion of the liver, and recurrences of malarial fever are often the result, all of which might have been avoided. Those who are suffering from serious tropical diseases, or who have not recovered sufficiently from their effects, will do well to dally at any of the health resorts of the Mediterranean which may have been recommended as suitable, and refrain from coming to England, until the month of June. Before this, the climate is usually unfavourable to recovery from chronic dysentery, malarial enlargement of liver, malarious cachexia, and tropical anæmia. Whereas, in conjunction with the appropriate treatment which can be commanded from English physicians practising at the southern sanitaria, sufferers are generally benefited by a stay there, until it is safe for them to proceed home. By the adoption of this course, the good effects of removal from the Indian climate and the sea voyage are maintained, and the chances of permanent restoration to health, after arrival in England, materially promoted."

Australian Health Resorts.

In these paragraphs we shall make some brief references to the climatic conditions in Australia, Tasmania, and New Zealand. Australia embraces a superficial area of 3,038,400 square miles, its greatest length from east to west being about 2500 miles, and from north to south about 1800. Moreover, one-third of it is in the torrid and the remainder in the south temperate zone. Tasmania, to the south of Australia, has an extreme length and breadth of 200 miles. New Zealand consists of two principal islands, about 1200 miles south-east of Australia, the united length of which, extending north-east to south-west, is 1163 miles, the mean breadth being 140 miles, and the total superficial area about 95,000 square miles.

We have put down these figures as explanatory of the fact that one cannot speak of the climate of Australia or New Zealand as if there were one prevailing kind of climate.

The seasons are: spring in September, October, and November, summer in December, January, and February, autumn in March, April, and May, winter in June, July, and August. The summer months are the months to be avoided, and the genial weather as a general rule begins about the last month of autumn and lasts till the middle of spring.

On the eastern side of Australia the northern portion is Queensland, the southern extremity is Victoria, and between the two is New South Wales. For purposes of convenience we have selected the chief towns of these divisions—Brisbane the chief town of Queensland, Sydney the chief town of New South Wales, and Melbourne the chief town of Victoria. The western side of Australia is called Western Australia, and we have taken Perth as illustrative of it. Between these eastern and western portions of Australia is a middle division, the southern part of which is South Australia, with its capital Adelaide. Hobart Town we have taken as representing Tasmania, Auckland as representing the northern island of New Zealand, and Christchurch and Dunedin as representing the southern island.

We have arranged these towns in a table, and have placed in columns the chief meteorological facts as to temperature, rainfall, &c., that we have been able to obtain.

	QUEENSLAND.	NEW SOUTH WALES.	VICTORIA.	SOUTH AUSTRALIA.	WESTERN AUSTRALIA	TASMANIA.	NEW ZEALAND (NORTH).	NEW ZEALAND (SOUTH).	
	Brisbane.	Sydney.	Melbourne.	Adelaide.	Perth.	Hobart Tn.	Auckland.	Christchur.	Dunedin.
Mean Annual Temperature, ...	70°	62°·4	58°	63°·2	65°	54°	59°·54	52°·88	50°·72
Highest Mean Monthly Temperature, ...	...	73°·04 Jan.	66° Jan.	73° Feb.	79° Feb.	61° Jan.	69° Feb.	...	...
Lowest Mean Monthly Temperature, ...	...	53°·24 July	48° July	51° July	53° July	45° July	51° July	...	...
Mean Daily Range of Temperature, ...	...	14°·7	...	...	...	16°	17°·82	17°·10	13°·68
Average Annual Rainfall, ...	50 in.	48·697 in.	26 in.	21·091 in.	33 in.	21 in.	51·84	25·536 in.	31·682 in.
Average Annual Rainy Days, ...	128	141	137	114	111	189	179	...	...

Brisbane is situated in the southern portion of Queensland. Its mean temperature is like that of Madeira. The winter season, from May to November, is the best of the year. Frosts are occasional, though not severe. The air is moderately moist, and the changes of temperature not so marked as farther south. The prevailing winds are from the south, cooling breezes in the southern hemisphere. Northwards from Brisbane the climate becomes more tropical in character. Westwards from Brisbane, inland that is to say, are several health resorts, situated at considerable elevations, and with a drier atmosphere in proportion to their distance from the coast. For example, **Dalby** (1123 feet above sea-level) is 152 miles west of Brisbane, in the district of the Northern Downs; **Harlaxton** (2003 feet) is 78 miles from the coast and

98 miles west of Brisbane. Its mean maximum summer temperature is said to be 82°, and in winter its temperature rarely falls below 32°. **Killarney** (1691 feet) is 73 miles from the coast and 194 south-west from Brisbane, and **Mount Perry** or **Tenningering** (2500 feet), 60 miles from the coast and 200 north-west of Brisbane, amid beautiful mountain scenery. All these resorts are recommended in lung affections, consumption, asthma, and such cases of bronchitis as need a moderately dry and bracing atmosphere. **Toowoomba** (1921 feet), 100 miles west of Brisbane, 80 miles from the coast, in the district known as the "Garden of Queensland," that of the Darling Downs, is recommended in convalescence from malarial fevers.

Sydney.—The winter season at Sydney is June, July, and August, and is generally very cold, mornings and evenings being chill and disagreeable. July is the coldest month, and the temperature may fall to nearly 42°. In the interior of New South Wales ice of slight thickness is occasionally met with. Dew is heavy and fogs are common on low-lying situations. The spring months are pleasant and clear. The heat of summer is moderated by the sea and land breezes, the period when the sea breeze dies down in the evening and before the land breeze begins being one of considerable oppression. The unpleasant feature of the summer is the occurrence of hot dry winds from the north-west, which occur, on an average, four times every summer, though they last not usually longer than twelve hours, during which time the thermometer may rise to 90°, 100°, and even higher. These winds suddenly change to a violent southerly wind, which is attended by a rapid fall of temperature and usually some rain. The temperature in one half-hour, while this change is in progress, may oscillate through a range of 20° or 30°. These rapid changes make the climate very trying to anyone with lung affection. The relative moisture of the atmosphere varies between 67·5 and 77·5 per cent of saturation, and is highest in autumn.

West from Sydney on the Blue Mountains are health resorts, suitable for the more trying months of summer. Such are **Bowenfels**, nearly 3000 feet above sea-level, 78 miles from the coast, and 97 west of Sydney, **Katoomba** (3349 feet), 66 miles west of Sydney and 58 from the coast, the summer temperature of which seldom exceeds 75°, **Lawson** (2399 feet), 58 miles west of Sydney. Beyond the Blue Mountains are **Bathurst** (2153 feet), 145 miles west of Sydney, with a mean annual temperature of 56°·8, and **Goulburn** (2071 feet), 134 miles south from Sydney, with a mean annual temperature of 55°.

Diseases of the lungs are common among those belonging to Sydney, chiefly among the young of both sexes. This, it is said, is due mainly to the sudden changes to which the temperature is subject, as already noted. Dysentery is also common. Infectious diseases of children are practically unknown. Sydney is, therefore, not recommended in advanced disease of the lungs. But the climate is so healthy and delightful, except in the three hot months when the north-west wind occurs, when, however, escape to higher regions is possible, that for those who, though not advanced in consumption, have yet a consumptive tendency, but who must find a residence in a town where employment is to be had, Sydney is one of the places to be named, though Tasmania is held in higher repute.

Melbourne, the capital of Victoria, was formerly held in repute as affording a suitable climate for consumptive patients. It is in winter colder than the localities already named; and it is liable to sudden and uncertain changes of temperature throughout the year. It is also subject to hot winds from the north and storms of dust, very injurious to any suffering from lung affections, and the deaths from consumption are now nearly as numerous as in large towns in England. December, January, and February are the hottest months, and July is the coldest. The hot winds of summer are followed by strong breezes from the southward, which cause a rapid fall in temperature, amounting to 20° or 30°. In autumn "cool winds, Italian skies, gentle rains (at night) and a bright clear atmosphere, impart a spirit of strength and activity to the inhabitants which is not surpassed by any country in the world." Mountain resorts are also within reach of Melbourne, principally to the north-east. **Beechworth** (1795 feet) is 171 miles north-east, with a temperature in December of 67° and in July of 40°, and is more suitable for chest affections than Melbourne itself. **Ballaarat** is 100 miles west, at an elevation of 1427 feet, and is a noted resort for invalids. Its December temperature is 60°, and its July temperature 42°, and its air is bracing and moderately dry. **Ballan**, 45 miles north-west, has mineral springs, used for digestive complaints and kidney affections. **Alexandra**, 90 miles north-east, is suited for lung and kidney disorders. It lies amid a mountainous country, at an elevation of 1000 feet. **Charlton**, 173 miles north-west, is much more equable, free of the sudden changes of temperature of Melbourne, and more fitted for consumptive patients.

Adelaide, the capital of South Australia, is 7 miles from the sea, has a milder temperature and more equable climate than Melbourne, but is inferior to Sydney and Tasmania for consumptives. December, January, and February are the hottest months and July the coldest. But the air is dry, and though in midsummer the temperature stands sometimes at 100° in the shade, the dry air renders it more tolerable than it would be in a moist atmosphere. Between April and October is the pleasantest season. In summer the hot north winds blow "like the blast from a furnace," accompanied by fine dust in clouds. Lung affections are common, and diarrhœal diseases.

Perth is the chief town in West Australia, a portion of the island said to be the healthiest of the Australian colonies. The table on p. 806 indicates a higher mean temperature than that of any of the other towns named, with a very hot summer. Its hottest month is February and the coldest are July and August, in which months the greatest rainfall occurs. The best season is from October to April; and the hot winds, which plague Melbourne and Adelaide, are not here so frequent or so severe. Western Australia, according to Mr. Ferguson, the colonial surgeon, has a death-rate of 12 per 1000, against 15 per 1000 for New South Wales and Tasmania.

Hobart Town is in the south of Tasmania. Tasmania has, on account of its smallness, a more marked insular climate than Australia. It is much more equable. Even in the height of summer the evenings and nights are cool and refreshing, and in winter the cold is never very great, not more severe, it is said, than that of the south of France. December, January, and February are the summer months, and the three following autumn months are the most enjoyable of the year. "The sky is then clear and serene, the days moderately warm, and the evenings and nights mild and genial." The north-west wind, which occasionally blows in summer, does not last long, though its heat and dryness are still unpleasant. The equability of the temperature make Tasmania more desirable for those suffering from lung affections than any of the Australian towns, though the comparative moisture of the atmosphere renders it still inferior to the high mountain altitudes of Central Europe, or of North and South America, for consumptives. It is very suitable for those exhausted by hotter climates.

Auckland, in the north New Zealand island, exhibits in its temperature (see table on p. 806) the chief characteristics of the New Zealand climate, equability and geniality. It is temperate also, and somewhat moist, the northern island being warmer than the southern.

Christchurch and **Dunedin** show the lower temperature of the southern island, though their range of temperature is not greater than that of Auckland, and if colder they are also equable. On the west coast of both islands the climate is less changeable than on the east coast. The rainfall on the west coast of both is very much greater than that on the east. Thus while at Christchurch on the east it is 25½ inches, at Hokitika, nearly opposite on the west coast, it is 112 inches. North-west winds prevail in the winter months and south-east in summer, but the hot winds are absent. The winter is severe at Christchurch and Dunedin, but more temperate and mild at Auckland and New Plymouth on the west coast of the northern island.

The diseases prevalent in summer are diarrhœa and dysentery, and a number of deaths occur from consumption throughout the year; and there is said to be a tendency among the colonists to rheumatic troubles.

It appears, then, that no locality in Australia, Tasmania, or New Zealand, is suited for advanced cases of consumption; that where a desire existed to avert a threat of consumption, not actually developed, Tasmania, Sydney, or Western Australia might be chosen, if the higher altitudes of the Swiss Alps or the Colorado Mountains were not open to the person; and that these islands of the southern hemisphere offer bright and genial climates to all in good health, and a pleasant and beneficial resort to those suffering from the enervating effects of tropical heat such as that of India.

PART III.

MEDICINES AND THE PURPOSES FOR WHICH THEY ARE EMPLOYED.

INTRODUCTION.

The Rational Employment of Medicines:
The Meaning of Therapeutics, of Rational and Empirical Treatment.
Modes of Administering Medicines:
Administration of Medicines by the Mouth, and by Injection into the Bowel;
Hypodermic Injection—Injection under the Skin;
Administration by Rubbing on the Skin, by Inhalation, by Baths, &c.
The Dose of Medicines:
Table of Doses suited to Different Ages.

The Rational Employment of Medicines.

The "practice of medicine," that phrase being used to mean the business or work of the medical practitioner, is inseparably associated, in the public mind, with the prescribing of drugs. The man who suffers from some discomfort, some disorder or other, a pain in his stomach, a pain in his head, a bad taste in his mouth, a want of appetite for his usual food, a cough, sleeplessness, or other ailment, presents himself before his doctor. What he expects to follow is something like this. He will inform the doctor that he suffers from indigestion, or that he "wants something for a bad cough," or that he is troubled with headache, or whatever his complaint may be; thereupon the doctor may go through a few formalities, such as looking at his tongue, feeling his pulse, and so on; then he will write a prescription, which the patient takes to a druggist; the druggist prepares, as ordered, a mixture—"a bottle"—or a pill, or a powder, which when the patient has taken, his stomach-ache or headache, or cough, or sleeplessness, ought to depart. These are the lines of the orthodox routine, "without which none is genuine," according to the generally held public view of the doctor's duties. There are, of course, variations in detail. One patient will interrupt the doctor, when he is about to ask a few questions, with such a remark as, "Oh! I know quite well what is wrong; it is just indigestion; can you not give me something for it?" Another is not sufficiently impressed with his adviser's care and attention unless the adviser puts him figuratively into the witness-box, examines and cross-examines him, produces a big book and duly enters the answers to the questions, and writes up a long statement of "his case." In the end, however, whatever be the course chosen, the bottle, pill, or powder must be ordered. That this is the view prevailing, more or less, among all classes, among the learned as among those unlearned, is daily illustrated in the work of every practitioner of medicine. "What is good for a cough, doctor?" "I wish you would give me something to cure my headache," and so on, are among the everyday requests, addressed to the medical man. There is some drug or other which is suitable for the removal of every ailment, is the general belief which prevails. If one doctor does not hit on the appropriate remedy another may, and so one doctor is tried after another, which is to say, one drug is tried after another, or one combination of drugs after another. If the cure is not obtained it is because the appropriate remedy has not been ordered or has not yet been discovered. One sufferer from indigestion has had some remedy prescribed which has proved effectual, and he hands round the prescription among any of his friends who suffer from a like complaint, with the perfect assurance that it will relieve them as it relieved him. The progress of medicine will thus consist in the discovery of new drugs, or in the application of drugs already known in new ways or for diseases they have not hitherto been supposed to be useful in. Now this is altogether a very imperfect view of the medical art, and an exaggerated notion of the value of medicines. The man who asks what is good for a cough, and expects an answer as promptly as he would to the question, what will remove ink-stains from linen? or what will cure a smoky chimney? overlooks the fact that his body is a complicated organism, a combination of numerous associated organs, working for a common end, the sphere of action of a multitude of intricate processes, and cannot be handled as a lifeless thing, a part of which can be acted on without the whole being more or less affected. He overlooks the fact that the healthy action of his body is the result of a multitude of conditions, connected with the food he eats, the water he drinks, the air he breathes, the clothing he wears, the house he dwells in, the daily work he performs, and the circumstances of his social life, and that the unhealthy action of his body may be connected with any, or many, or all, of these conditions. The man who treats disease on rational principles does not seek simply to determine what is the proper name to attach to a complaint from which his patient suffers, in order to say what drug is suitable for it. He seeks rather to obtain a knowledge of the conditions under which his patient lives, of the manner in which the various organs of his body are performing their work, whether their performance is of a healthy kind; if not, wherein they are defective, or wherein they depart from the healthy standard. When he has determined these things to his satisfaction, he asks himself how this departure has arisen, what is keeping it up, what is encouraging it or preventing a restoration to the natural state of things. When the information thus obtained is before him, he probably has the means of deciding how the unhealthy action may be prevented, how a return to the healthy action may be promoted, what procedure is likely to encourage a restoration to health. It may be that to achieve this desired end drugs are not necessary, may, perhaps, be hurtful rather than the reverse. It is only too likely that the reason of the disturbance of the healthy activity of the body will be found in some of the conditions of the patient's life, in some error of eating or drinking, in some unhealthy state of the air of house or workshop, in some circumstance connected with the patient's trade or occupation. If the reason of the disturbance is found and removed, then the natural tendency of the body to conduct its operations in a particular way—the way for which it was designed, the healthy way—may be sufficient to restore health, and the cure is thus effected without drugs. It may be possible to quicken the process of restoration by administering some substance which is known to have some particular effect upon a certain organ of the body, by whose effect the disordered action may be lessened and the tendency to return to the natural action encouraged. In which case the medicine is ordered; but it is not the cure; it is only one of the helps to a cure. It is given only to reinforce the other means set in operation to effect a return to health.

The treatment of disease, then, is not solely, nor mainly, the administration of medicines. The administration of medicines is only one of the means of treating disease, one of many means, though undoubtedly, when wisely directed, a very valuable means. The tendency to return to natural healthy action—the *vis medicatrix naturæ*, the healing influence of nature—or, from another point of view, the natural resistance of the body to disease, is what the wise physician mainly relies on really to cure the disease. This influence he encourages, excites, stimulates; difficulties in its way he tries to modify or remove; he "stands by," to use a nautical phrase, to modify or avert any interference with its full play which he sees likely to arise, or finds actually existing. For this purpose he directs the kind of food and drink to be taken, the most suitable climate, and for this purpose he employs what medicine he deems advisable. So it is that the use of medicines is only one, and not the chief, means adopted in the treatment of disease. The word **therapeutics**, therefore, which is commonly used in a narrow sense to imply the use of drugs in the treatment of disease, has a far broader meaning. It is derived from the Greek *therapeuo*, I heal, or I treat, and it really includes every means employed to restore a healthy state to the body.

These considerations will help us to understand the kind of knowledge that is needful for the successful employment of medicines. The physician must first know what the healthy action of the body really is. He must learn what the healthy action of the heart, lungs, liver, bowels, nervous system, all the organs of the body, is. He must be able to appreciate what changes are produced in those healthy activities by various states of disease; he must be able to search for, and detect, a departure from the natural state, and understand its nature and its effects. He is not yet ready, however, to treat disease. It is not enough to know how the body works, so to speak, when it is in health, nor yet sufficient when, to that knowledge, is added an ability to discover when it is working badly and why. For he does not yet know how its healthy action is affected by various conditions, nor how he can bring influences to bear on its disordered action. To the knowledge of how the body works when in health, must be added an understanding of the various means by which that healthy action can be influenced. For example, a man may know a great deal about the action of the heart, how often it contracts during one minute, with what force it contracts, what the order of its movements is, what are their effects, and so on, and yet be unable to tell how the action of the heart may be quickened or slowed, weakened or strengthened. Or again, one may know a good deal about the liver, what is the build, size, shape, position of the organ, about its work in the body, about the bile which it produces, what its chemical and other properties are, and so on, and yet have not the smallest knowledge of any means by which the liver may be stimulated to increased action, to produce more bile, or how its action may be diminished so that it produces less, and so on. If one is not aware how the various activities of the body may be influenced by conditions either within or without the body in a state of health, how can one understand how to influence the action of the various organs when there is some state of disease? If one cannot tell how the action of the healthy heart may be strengthened, how is one to know what to do to strengthen a heart so weakened by disease, as to have become almost unfit for its work? If one is not aware what will slow the movements of the healthily beating heart, how is one to know what to do to diminish the speed of action of a heart beating with a rapidity which threatens rapid exhaustion of all power to beat at all? If one is not aware how to stimulate the flow of bile from the liver in a state of health, how is one to know what to do to "poke up" a liver which has become slow in the performance of its share in the work of the body. The training of the physician, then, implies the opportunity of becoming acquainted with the effects upon the body, and upon its various organs when in a state of health, of various conditions and substances, and an acquaintance, so far as that can be gained, with the effects of similar conditions and substances on the manifold disordered states to which the body is subject. The knowledge of the influences that may be brought to bear upon the *healthy* body it is the business of the science of physiology to acquire, and the effect of any substance upon the body in a state of health is said to be its physiological action. The study of the effects upon the body in a state of disease belongs to the science of therapeutics, the science of treatment.

Well, then, the points we have been trying to emphasize are: *first*, that the treatment of disease is not entirely or mainly an affair of drugs—the administration of medicines is, indeed, only a small part of it; and, *second*, that the administration of medicines is not, or ought not to be, an affair of happy chance, or hap-hazard, or rule of thumb, but ought to be determined by (1) a knowledge of the healthy action of the body, (2) a knowledge of the effects of disease in altering healthy action, (3) a knowledge of the influences that can be brought to bear upon the body in health and their mode of operation, and (4) a knowledge of the means by which the body and its various organs can be influenced in a state of disease. What, then, is meant by the rational employment of drugs will be understood. Let us take an example:—A person is attacked with inflammation of the lungs. The physician knows how the lungs should act in a state of health, this physiology has taught him; his study of pathology—the science of disease—has revealed to him how that action is interfered with by various states of disease, and how the particular kind of disease is determined. His examination of the person has shown him the condition of the affected lung, and he has found that a large part of one lung, let us say, is filled up with the products of inflammation so that it can no longer do its share of the work of introducing oxygen to the blood and removing carbonic acid gas from it. This condition of the lung is such that the blood flows through it with great difficulty, that the heart, which drives the blood through it, has enormously increased labour thrown upon it to carry on the circulation, and, besides, the state of fever, the interference with digestion, caused by the disease, and so on, are producing exhausting effects upon the whole body, and on the heart as part of it. For all these reasons the heart has become enfeebled, is showing signs of tiring, so to speak, is weak and irregular in its action, and the risk exists that the patient will die, not directly because of the inflamed lung, but because the heart will fail altogether, because of the undue strain thrown upon it. In a few days the physician expects that the inflammation will abate, and the lung will begin to clear up, and the strain upon the heart will lessen. Meanwhile, however, it is questionable if the heart can hold out till relief begins. So the physician asks himself what can be done to steady the action of the heart and strengthen its contraction, what can he do to aid it to tide over its time of difficulty. The study of the action of medicines has taught him that a drug, digitalis, diminishes the frequency of the heart's beat and increases its force, and his knowledge of the diseased state indicates that this is the effect that will prove beneficial. So he orders digitalis. He does not simply order a mixture, containing digitalis, and cause a teaspoonful, or any other quantity to be given, mechanically, every three hours, or four times a day, or whatever it be, but he watches its effects. He finds the heart is a little improved, but not very markedly, so he increases the dose; and after a little time longer, it may be, he increases it still more, till he reaches a dose when the effects he desires are obtained, the heart now beats steadily and firmly. Meanwhile his treatment of the inflammation of the lung goes on. In a few days the lung begins to clear up, the difficulty begins to decrease; he begins now slowly to diminish the digitalis, and at length finding the heart no longer fails, is now no longer oppressed with labour, he can safely stop the digitalis altogether, his timely aid having been sufficient, while the time of undue labour lasted.

This is an illustration of a drug rationally employed. The effect to be produced is understood, a drug which can produce this effect is known, and so the drug is given till the desired result is achieved. Let us take another example of a different kind. A person has, by accident, swallowed a poisonous dose of corrosive sublimate—a salt of mercury. If the drug passes into the circulation and is, by the blood, distributed throughout the body in sufficient quantity, its effects will kill him. Obviously the rational treatment is to get the poison out of the stomach before it has had time to be absorbed in sufficient quantity. So the doctor applies the stomach-pump, empties and washes out the stomach. Perhaps a stomach-pump is not at hand, so he tries to make the stomach empty itself; he excites vomiting by tickling the throat with a feather, or putting the finger down. Some of the poison may still be left in the stomach, adhering to its walls, can he give anything which will prevent the poison passing into the circulation? It can only pass into the blood if it is in a state of solution; if the corrosive sublimate is not dissolved, it cannot gain entrance to the blood, and so will do no harm. Now corrosive sublimate forms with albumin an insoluble substance, albuminate of mercury. White of egg consists chiefly of albumin, so the whites of several eggs are rapidly beaten up in water and given to the person to drink, and thus an antidote to the poison is administered.

Now it is not always possible to make use of drugs because of such well-defined reasons as these. Many medicines are used for particular diseases in which their effects have been proved by experience to be useful, and yet the reason of their usefulness, the exact means by which they are beneficial, are not known. Experience only has taught that they are useful, in certain cases, but the reason of their usefulness remains to be discovered. Whether they relieve, or whether they fail to relieve, no scientific reason is yet forthcoming. In such cases the medicine is said to be given **empirically**, and the treatment is said to be empirical treatment. It is undoubtedly the case that a very large number of the remedies regularly employed, including some of the most useful of the remedies in the hands of the physician, are used because experience has shown their value, although the reason of their usefulness is not at all or not well understood. But physicians do not refuse to order medicines, which have been shown without doubt to be appropriate in certain cases, because they do not yet know how they bring about the desired end. It is, however, the object of the modern science of medicine, bringing chemistry and physiology and pathology to its aid, gradually to reveal more and more clearly how these remedies act, and so to increase the number of the drugs which are employed because their mode of action is well understood, and to diminish the number of drugs which are recommended merely because of the facts of experience. This result the science of medicine is gradually achieving; and year by year drugs are being taken out of the class of those used empirically and added to the number of those used rationally. A most notable illustration of this is found in the well-known medicine quinine. Long ago quinine and Peruvian or cinchona bark, from which quinine is derived, were known to be invaluable medicines in the treatment of fevers, and specially of those—such as ague—dependent upon malaria. The cure of ague was regarded as almost a certainty by the administration of quinine long ago, and as late as 1857, Sir Thomas Watson said of it: "I may observe, however, that this is a remedy to which we could never have been led by any process of reasoning. It is a matter of pure empiricism. We know nothing of the seat or of the essential nature of the disease (ague); we are equally in the dark as to the *modus operandi* of the quina in curing it; yet our knowledge of ague, upon the whole, estimated in reference to its precision and practical bearing, is more satisfactory than of many other complaints, with the seat and nature of which we are much better acquainted. The group of symptoms is so distinct, that we have no trouble or doubt as to the diagnosis; and experience has taught us a remedy which is all but infallible." This might have been said of quinine up to a much later date. Now, however, physiological investigations have revealed much of the way in which quinine acts in controlling certain kinds of fever, and concerning it we may now be said to have passed beyond the mere stage of experience. How salicine, derived from willow bark, acts so marvellously in rheumatism, diminishing the fever, relieving the pain, and removing the swelling, it is impossible to say, yet experience warrants one in almost asserting that in a few hours acute rheumatic fever will yield to its use.

While this is so, still the object of all those who work in the various departments of medical science is to reduce it more and more to the limits of an exact science, to discover the real nature and ultimate causes of disease, to ascertain the actions of drugs in health and in disease, so that those who practise the art of medicine shall always have well-defined reasons for the employment of all the means of meeting disease, and shall have more and more certainty of successfully combating and overcoming it.

Modes of Administering Medicines.

Medicines produce both what is called a local and a remote effect. That is, they act directly upon the part with which they come into contact, and they also act upon parts distant, usually by passing into the blood and being carried thence to other parts of the body. Sometimes it is only the local effect one wishes to produce, as when carbolic acid or other similar substance is applied to an ulcer to convert it into a healthy sore, sometimes one wishes to get the medicine into the blood only so that it may be carried to the distant organ. The usual way of getting the medicine into the system is by giving it by the mouth. It is then swallowed, and passes into the stomach. From the stomach it is absorbed by the blood-vessels, and thus carried through the whole body in the blood stream. Reaching all parts of the body, it may influence all the tissues and organs, but commonly one or more organ is affected more than others, and a special effect is thus produced. Often there are objections to giving it by the mouth. One may desire to avoid its local action on the walls of the stomach, the irritability of the stomach may be such that the substance is vomited speedily after it is swallowed, and another method of introduction is desirable. In such a case the medicine may be mixed with a solution of some non-irritating material like starch and injected into the bowel, from which it is absorbed and passes into the blood. Or the drug may be dissolved in a few drops of water and injected under the skin. This is called *hypodermic injection* (Greek, *hupo*, under, and *derma*, the skin). The instrument used for the purpose is a hypodermic syringe. It is a small, usually glass, syringe, capable of holding 20 or 30 drops, the barrel of the syringe being marked so that the number of drops injected may be easily known. To the nozzle of the syringe is screwed a long slender needle, with a fine canal running through it, and ending in a sharp point. The solution being sucked up into the syringe, the needle is screwed on; slight pressure on the piston drives the solution along the needle till its canal is filled, then the skin is picked up between finger and thumb and the needle thrust through it. The piston is then pressed till the requisite quantity is injected. On withdrawing the needle one presses over the puncture to prevent escape and gently rubs the skin over the seat of injection to cause the fluid to be diffused through the tissue under the skin, and so ensure it being rapidly picked up by the vessels—blood-vessels and lymphatics. This is one of the quickest ways of procuring the action of a drug, it so rapidly gains entrance to the current of blood. A drug may be rubbed on to the skin, and it will produce an effect not only on the part to which it is applied but also on the system in general, because, if well rubbed in, it gets into the vessels. Occasionally the top skin, or scarf skin, is removed by a blister, and a drug, in powder, sprinkled on the raw surface. Some is absorbed and produces remote effects. Then drugs are sometimes caused to enter the body by inhalation—the drug is disseminated through the atmosphere in vapour, and the vapour being breathed, and the drug getting into the lungs, is absorbed by the vessels of the moist delicate mucous membrane. The drug may be converted into vapour and the naked body exposed to its influence, the arrangement being that described for the vapour bath (p. 738). In such a case it is absorbed by the skin. Medicated bath may be given as a means of introducing the medicine into the body. Finally, the speediest method of all would be to inject the drug directly into the blood by a vein, *intravenous injection*, but this method is seldom employed. The speediest method commonly employed is that by hypodermic injection. A small quantity of the drug, thus given, will act as effectually as a larger dose by the mouth, for it enters the circulation more quickly, and there is a larger quantity circulating at one time. When the drug is given by the mouth, its absorption from the stomach is so much slower, comparatively speaking, that some of it may be already expelled from the body by way of the kidneys, skin, and lungs, before the last of it is absorbed. Then the juices of the stomach, &c., may so act upon the medicine as greatly to change its nature and prevent its full action being produced, an effect avoided by injection under the skin. Thus everything absorbed from the stomach passes through the liver, and the medicine may be much altered in its course. Therefore, a much smaller dose is given by hypodermic injection than would be given by the mouth or bowel.

Dose of Medicines.—The dose of medicines should be regulated by the body weight, for the same dose administered to a small and a large person will be distributed through a smaller quantity of blood in the small person, and thus each organ of the body will receive a larger share than the corresponding organs in the person of greater size. Women, therefore, require a smaller dose than men, and children than grown persons. Age is regarded as the convenient guide in regulating the dose. One rule for fixing the dose for a certain age is to take the age in years of the person, add to it 12, and with the sum divide the age in years, the result expresses the fraction of the full dose to be given. Thus a child's age is 4 years, 4 added to 12 makes 16. Divide the age in years by 16—$\frac{4}{16}$th is the fraction of the full dose for a child of 4 years. $\frac{4}{16} = \frac{1}{4}$, and if the full dose is 4 grains, the child should get 1 grain. The following table may be taken as a guide:—

A child under	1	year	will require only	$\frac{1}{12}$	part of the full dose.
,,	2	years	,,	$\frac{1}{8}$	,,
,,	3	,,	,,	$\frac{1}{6}$	,,
,,	4	,,	,,	$\frac{1}{4}$	,,
,,	7	,,	,,	$\frac{1}{3}$	,,
,,	14	,,	,,	$\frac{1}{2}$	,,
A young person under	20		,,	$\frac{2}{3}$	,,

A person above 21 receives the full dose.
After 65 years of age the dose is diminished.

It may further be noted that young persons are much more susceptible to the action of certain drugs than are old persons. For instance, children are peculiarly strongly affected by opium, or any of its preparations, such as laudanum, and to them it cannot, therefore, be given too carefully. On the other hand children are *less* affected by preparations of mercury than are adults; and there are instances on record of calomel, a preparation of mercury, having most serious effects on an adult, when given in a dose which almost the youngest child could stand. Another drug to which children are less susceptible than adults is belladonna.

Besides all this, custom, temperament, the influence of climate, and personal peculiarities affect the question. Many people are peculiarly affected by certain drugs, even as many are peculiarly affected by certain foods, while others are hardly influenced at all except with large doses. Opium and mercury are notable illustrations; the smallest doses of these being scarcely tolerated at all by many persons.

We shall now proceed to consider some of the chief remedies and means of treatment in their effects upon the body, and their use in disease, considering them as far as possible according to the organs of the body they chiefly influence.

SECTION I.—MEDICINES WHICH ACT UPON THE BLOOD AND WHICH AFFECT THE NUTRITION OF THE WHOLE BODY.

Medicines which Act upon the Blood.

Blood Tonics:

Iron—Its Preparations and their Doses—Tincture of Steel, Iodide of Iron, Chemical Food, Blaud's Pill, &c.—Its Action and Uses in various Diseases.

Medicines which Increase or Diminish the Alkalinity of the Blood:

Potash—Its Preparations and their Doses—Carbonate and Citrate of Potash, &c.—The Use of Potash in Rheumatism, Gout, and Gravel;

Soda—Bicarbonate of Soda and Rochelle Salts;

Lithia—Its Use in Gout.

Remedies which Cool the Blood—Antipyretics:

Quinine and Peruvian Bark—The Varieties of Cinchona Barks—The Preparations of Bark—The Preparations of Quinine—The Use of Quinine as a Tonic, for Fever and Ague, and as a Disinfectant—Warburg's Tincture;

Salicine—Its Use in Rheumatism;

Salicylic Acid and Salicylate of Soda;

Antipyrin—Its Employment for Fever, and its Use for Nervous Headache;

Thallin, Antifebrin, and *Kairin.*

Medicines which Act on Tissue Change.

Alteratives:

Arsenic—Its Chief Preparations—Precautions in its Use—Arsenical Poisoning—Its Use in Skin Diseases;

Mercury—Its Compounds, Action, and Value—Mercurial Poisoning;

Iodine and Its Use in Scrofula and Gland Diseases;

Phosphorus and Its Preparations;

Sulphur—Its Use in Liver Disorders and Skin Affections—Sulphuretted Hydrogen Treatment in Consumption;

Sarsaparilla;

Colchicum—Its Employment in Gout;

Guaiacum—How applied for Sore Throat and Rheumatism;

Mezereum Bark.

In the first part of this work we have considered the characters and composition of the blood (see p. 212); we have considered also the part which the blood plays in the body. We have seen that the whole body, and every part of the body, are dependent upon the blood for the material for their healthy growth and for the material for their healthy activity. The blood is the nourishing fluid of the body, containing within itself all the materials for the building up of every tissue, muscle, nerve, bone, skin, and so on, for the production of every juice required in the body, the digestive juices for example, and for the repair of all tear and wear, continually going on. It is distributed to every organ, and brought within reach of every tissue; and the tissues possess the power of selecting from it the constituents they require for their continued healthy existence. We have considered also how the blood, thus continually being drained of its nourishing materials, is as continually restored to a healthy standard and maintained in a condition fit for the purpose it has to serve. The means for this purpose are mainly food and drink introduced by the mouth and prepared for entering the blood by the digestive organs, and oxygen gas, which the blood obtains through the instrumentality of the lungs. Our earlier studies have also shown us that the blood is, besides, a means of removing from tissues and organs the waste products, due to the activity of the organs and tissues, and how the liver, the bowels, the lungs, the kidneys and the skin, act in ridding the blood of these waste substances and thus maintaining its standard of purity. Through the blood, then, the condition of the whole body may be influenced. If it is impoverished or impure, the organs and tissues will not derive the needed nourishment; or some organs may obtain a fair supply and others may feel the impoverishment more; or along with the needed material for growth and work may also be obtained, because of the impurity, something hurtful to the healthy action of the organ or tissue. If some additional substance be taken into the stomach, which is able to pass into the blood, it will be carried to all parts of the body. If it is an active substance it may affect more or less every organ and tissue of the body, or it may be of a character fitted to act upon one organ more than another, and may profoundly affect the whole body by its universal action or by specially influencing one or two organs in partciular.

Thus, then, it is plain there are two great ways of influencing the nutrition of the whole body in general: (1) either by acting directly on the blood, or (2) by introducing something into the blood which shall be conveyed by it to all parts of the body and shall modify the action of the tissues when it arrives there. To the first class of remedies belong **blood tonics**, of which the conspicuous example is iron; while the second class is called **alteratives**, that is, they alter or modify the changes going on in the tissues, though how they do so is not well understood, and to that class arsenic, mercury, iodine, and others to be named later, belong.

MEDICINES WHICH ACT ON THE BLOOD.

The blood (see p. 216) consists of minute bodies, corpuscles, red and white, floating in a fluid, liquor sanguinis or plasma. Now the red corpuscles are formed of an albuminous body, hæmoglobin, which contains iron, and they also contain salts of potash and phosphorus, and fat. These red corpuscles give the colour to the blood, and if they are deficient in number, the paleness of the skin is marked, and a condition of bloodlessness, or anæmia, is the result. By supplying to the blood iron, fat, potash salts, the constituents of the corpuscles, much can be done to remedy this condition, supposing, of course, that at the same time appropriate food is given, and fresh air and sunlight and exercise are not forgotten. Then, again, the liquid of the blood contains albumin, soda salts, fat, &c., and by a due supply of these substances an improved condition may be brought about. Because of the soda and potash salts of the liquid and red corpuscles of the blood the blood is not acid but alkaline, and in certain diseases, notably rheumatism and gout, the alkalinity is diminished. By administering soda or potash salts it can be increased, and this is actually part of the treatment in the diseases named. Again, scurvy, a disease in which the nutrition of the whole body is profoundly impaired, is believed to be due to the absence from the blood, or deficiency, of some of its constituents, perhaps potash salts, to be remedied by giving fresh meats and vegetables which contain the salts, or by the use of lime-juice.

Thus we see how the condition of the blood can be influenced by the administration of substances which are needed for its formation and which otherwise act upon it directly, and how in consequence the nutrition of the whole body may be improved.

Then, again, the red corpuscles, because of the hæmoglobin of which they are mainly composed, act as the distributors of oxygen gas to the tissues, without which their activity cannot be carried on. The hæmoglobin forms a loose chemical compound with oxygen, and when the blood obtains the oxygen in the lungs, it is forthwith carried to the tissues and delivered up to them, so to speak. If the corpuscles are deficient, then oxygen in sufficient amount cannot readily be carried to the tissues. They cannot carry on their processes with ordinary activity, and all the energies of the body become, in consequence, diminished; the patient is weak, languid, dull, sleepy; and the heart is greatly quickened and the breathing hurried with the least exertion, perhaps in the attempt to make up for the defective oxygen-carrying capacity of the blood by increasing the rate of its distribution through the body, that is to say, by making the corpuscles travel all the oftener between the lungs and the tissues. By the administration of iron with appropriate food, &c., the multiplication of red blood corpuscles is encouraged, and relief in time obtained.

Now there are drugs which interfere with the yielding up of oxygen to the tissues by the red corpuscles. The corpuscles duly bring their load of oxygen, but are prevented handing it over, so to speak. This is an effect which is produced by alcohol, and is also produced by quinine. It is an effect which one would not seek to produce in health, but is often exceedingly valuable in disease. For instance, in fever the heat of the body is greatly increased, owing, in certain fevers at any rate, to too great *production* of heat in the body. We know that heat in the body is produced in the same way as heat outside of the body is produced (see p. 527), by a union of certain substances, carbon and hydrogen, with oxygen. The substances that unite with the oxygen are in the tissues, and the oxygen, as we have said, is brought to them by the blood. If the oxygen is so firmly united to the corpuscles that it is given off from them with difficulty, the chemical combination will be diminished and less heat will be produced. This is the effect of quinine, and thus in cases of fever it diminishes the heat of the body by lessening the production of heat, by preventing the corpuscles giving up their oxygen so quickly as they would otherwise do.

The general action of remedies on the blood having thus been briefly indicated, we shall now shortly note the chief points of importance connected with the drugs.

Blood Tonics.

Blood Tonics are remedies which improve the quality of the blood by supplying materials in which it is deficient. The chief of them are also called **hæmatinics,** because they increase the quantity of colouring matter in the blood.

Iron in some form is the chief blood tonic. The chief preparations of iron in common use and their doses are as follows:—

	DOSE.
Reduced Iron	2 to 6 grains.
Saccharated Carbonate of Iron	5 to 20 ,,
Sulphate of Iron	1 ,, 5 ,,
Dried Sulphate of Iron	$\frac{1}{2}$,, 3 ,,
Phosphate of Iron	5 ,, 10 ,,
Syrup of Phosphate of Iron	60 drops.
Tincture of Steel (Tincture of Perchloride of Iron—Steel Drops)	10 to 40 drops.
Dialysed Iron	10 ,, 30 ,,
Iron Wine	1 to 4 tea-spoonfuls.
Tartrate of Iron (Potassic Tartrate of Iron)	5 to 20 grains.
Citrate of Iron and Ammonia	5 ,, 10 ,,
Citrate of Iron and Quinine	5 ,, 20 ,,
Iodide of Iron	1 ,, 5 ,,
Syrup of Iodide of Iron	20 to 60 drops.
Arseniate of Iron	$\frac{1}{10}$ to $\frac{1}{8}$ grain.

Griffith's Mixture (compound mixture of iron) is a favourite iron mixture, containing sulphate of iron (25 grains), carbonate of potash (30 grains), powdered myrrh (30 grains), spirit of nutmeg ($\frac{1}{2}$ oz.), sugar (60 grains), and rose-water (9 fluid ounces). Dose—1 to 2 fluid ounces.

The myrrh, spirit of nutmeg, and carbonate of potash are rubbed up together in a mortar, then the rose-water is added and well mixed, then the sugar, and lastly the sulphate of iron. It should be kept in a stoppered glass vessel.

Parrish's Syrup or **Chemical Food** is another favourite remedy, containing phosphate of iron, with the phosphates of lime, potash, and soda, dissolved in dilute phosphoric acid and sugar added. Dose—1 tea-spoonful.

Easton's Syrup is a syrup containing phosphate of iron with the phosphates of quinine and strychnine. Dose—$\frac{1}{2}$ to 1 tea-spoonful.

Syrup of the Hypophosphites contains iron, lime, potash, soda, &c., as well as other ingredients like quinine and strychnine. Dose—$\frac{1}{2}$ to 1 tea-spoonful.

Blaud's Pill contains sulphate of iron and carbonate of potash. In the stomach carbonate of iron is formed. It is a very good form for the administration of iron.

Action and Uses of Iron.—The preparations of iron have an effect upon the tissues with which they come into contact before they enter the blood. Thus the astringency of most of the preparations is perceived by the action on the mouth. They discolour the teeth, and thus when not given in the form of pill, but as a liquid, they should be taken through a glass-tube, a straw even would suit the purpose, and the mouth and teeth should be well washed afterwards. They exert a constringing effect upon the lining membrane of the throat, gullet, stomach, and bowels. They cause blood to contract and form a clot with albuminous bodies, such as blood. Now this purely local action is often useful, and they are, therefore, used to diminish discharge from organs, to arrest bleeding, and for similar purposes. Thus, besides being given by the mouth to produce such local effects on the mouth or throat, stomach or bowels, they are employed as injections, in cases of bleeding from the nose, bleeding from gums, from leech-bites, &c. In some of the preparations these effects are specially marked, the tincture of steel and sulphate of iron, for example. It is the same action which makes iron preparations valuable in cases of relaxed bowel, diarrhœa, and so on. The astringency, however, causes iron to be badly borne by many persons, persons with irritable stomach for example, and is disadvantageous in cases where there is no looseness of bowels, from the tendency to cause constipation. It is, therefore, common to combine with the preparation of iron some substance which will have an opening effect. Thus the iron-and-aloes pill acts upon the lower bowel, securing a movement, while the benefits of the action of iron are also obtained. It must be noticed also, that iron preparations colour the motions black, owing to the formation in the bowel of the black sulphide of iron.

In cases where the local action is not specially desired, one seeks to make use of those forms of the remedy which have the least constringing action, since this effect is apt to irritate the stomach and bowels. If the person has a red, raw-looking tongue, this is held to indicate an irritable condition of stomach, when iron would not be given, or only in the mildest form in small doses. When the tongue is pale, flabby, and shows the marks of the teeth on the edge, iron is suitable. The least astringent forms are the reduced iron and dialysed iron specially, the saccharated carbonate of iron, the phosphate, tartrate, and citrates of iron, and the hypophosphite.

The direct action of iron on the red corpuscles is the peculiarly valuable effect for which iron is most usually administered, its effect upon the organs and tissues being practically none, except through the improved quality of the blood which it produces. It is thus the most useful drug in bloodlessness (anæmia), in all conditions of impaired nutrition, in cases of wasting due to loss of blood or chronic discharges, in the condition of weakness following fevers, in scrofula, in malarial poisoning, in blood poisoning, in diphtheria, erysipelas, &c. For the two last-named diseases it is given in large doses, the tincture of steel being very useful in 10-drop doses given in water five times a day, or the dialysed iron. The carbonate of iron, Griffith's mixture, Blaud's pill, and the syrups of the phosphates or hypophosphites are also the most serviceable. In chronic kidney disease it is also used. In nervous diseases, and in the flushings experienced at the change of life, any of such preparations is most valuable. In nervous cases the combinations with strychnine, such as in the compound syrup of hypophosphites or Easton's syrup, are those to be employed.

The citrates of iron are the mildest preparations. and may be given when it is doubtful if other forms will be well borne.

In cases of deficiency of the menstrual flow the carbonate of iron and Blaud's pill are commonly employed.

The combination of iron with iodine, and specially the syrup iodide of iron, is one of the most valuable remedies for scrofula and affections of glands; and there is scarcely a better remedy than this for the pale, flabby, unhealthy children of towns, given to the extent of 15 drops or thereby, dropped into a teaspoonful of cod-liver oil, three times daily. Nervous diseases of children derive great benefit in many cases from such treatment. The syrup of the phosphate of iron is suitable for rickety children.

The compound of iron and arsenic is useful for skin affections in pale persons, and for other anæmic conditions, but it ought scarcely to be used without proper advice.

Iron is an antidote, in one of its forms, to poisoning by arsenic. The form used is the hydrated oxide, when freshly prepared, by adding a solution of soda or ammonia to the tincture of perchloride of iron in water, or to a solution of the sulphate of iron. It forms with the arsenic an insoluble compound. A brisk purgative should afterwards be given.

Medicines which Increase or Diminish the Alkalinity of the Blood.

The chief remedies which increase the alkaline character of the blood are potash, soda, magnesia, lime, and lithia.

Potash.—The chief preparations of potash are as follows:—

	DOSE.
Carbonate of Potash	10 to 30 grains.
Bicarbonate of Potash	10 ,, 40 ,,
Solution of Potash (Liquor Potassæ)	15 ,, 60 drops in a wine-glassful of water.
Iodide of Potassium (see p. 825)	2 to 10 grains.
Bromide of Potassium	5 ,, 30 ,,
(See under Drugs which Act on the Nervous System.)	
Citrate of Potash	20 ,, 60 ,,
Acetate of Potash	10 ,, 60 ,,
Nitrate of Potash	10 ,, 30 ,,
Chlorato of Potash	10 ,, 30 ,,
Acid Tartrate of Potash (Cream of Tartar)	60 grains and upwards.

Actions and Uses of Potash.—This remedy produces very different effects according to the form in which it is used, and acts on many organs, according to the dose given. Thus caustic potash, usually in the form of white pencils, is employed for its destructive action on the tissues to destroy unhealthy ulcers, remove tumours, &c. Then potash is employed for its chemical antagonism to acid, being given to neutralize acidity of the stomach as soda is given. For this purpose the bicarbonate is the best. The solution of caustic potash (liquor potassæ) is also employed, but it requires to be largely diluted; it cannot be taken to any extent because of its corrosive action; and is not to be recommended. Then the action of the bromide and iodide of potassium depends chiefly on the bromine and iodine in combination, and these substances are discussed elsewhere. The carbonate, bicarbonate, tartrate and acid tartrate act in large doses on the bowels, producing copious watery stools. This action is referred to in considering the drugs acting on the bowels. Again, the citrate, acetate, and nitrate act specially on the kidneys and are, therefore, considered in the section devoted to drugs which act on the kidneys.

It is the action of potash on the blood that is to be mainly noted here. It readily gains entrance to the blood, increasing its alkaline reaction. Then the red corpuscles contain potash salts, and in disordered conditions of blood the use of potash, *in combination with iron*, greatly improves the quality of the blood by increasing the number of red corpuscles. For this purpose the best form is Blaud's pill (see p. 817) or the compound iron mixture (see p. 817). Potash is used by itself in diseases supposed to be due to an excessive amount of acid in the blood, such as rheumatism and gout. For this purpose the bicarbonate, the citrates, acetates, and tartrates are employed. Nitrate of potash—saltpetre—is an old remedy, in high repute, for rheumatism. These drugs, after passing into the blood, where they are mostly converted into carbonates, are excreted by the urine, the acidity of which they diminish, or, if in sufficient quantity, altogether remove. They are, therefore, valuable for relieving the scalding due to the irritating effect of excessively acid urine, and to prevent the formation of stone by the deposit of uric acid. Then in being excreted by the kidneys they so act upon them as to produce a greatly increased flow of urine. Owing to the increased separation of water from the blood, dropsies of various kinds are diminished, because the fluid of the dropsy is picked up to restore to the blood its normal quantity of water. The citrate of potash is useful as a preventive of scurvy.

The chlorate of potash is principally used for its local action on ulcers, thrush, and other similar affections of the mouth, throat, stomach, &c. It very speedily exerts a cleansing and healing action on the lining membrane of the mouth and throat affected by patches of ulceration, &c. It is, therefore, used in these conditions and in cases of relaxed throat, in diphtheria, &c. A very convenient form of administration is the pellets, containing 5 grains each, now to be had of nearly every druggist, and the chlorate of potash pastilles. It is said, also, when it gains entrance to the blood, to give up some of the oxygen, in which it is rich, and thus act upon the blood after the manner of a disinfectant in cases of diphtheria, blood-poisoning, &c.

Soda.—The chief preparations of soda are:

	DOSE.
Carbonate of Soda	5 to 30 grains.
Bicarbonate of Soda	10 ,, 60 ,,
Tartrate of Soda and Potash (Rochelle Salts)	¼ ,, ½ ounce.
Phosphate of Soda	¼ ,, 1 ,,
Borax (Biborate of Soda)	5 ,, 40 grains.
Hyposulphite of Soda (see Section III.).	

Soda in the form of chloride of sodium or common salt is present in all the tissues and fluids of the body, and is introduced with all foods, existing as it does in them as part of their constitution, and being commonly added to many as a matter of taste. Perhaps it is on this account that soda does not have any peculiar action on any organ or tissue of the body.

What has been said of the salts of potash is true of those of soda, only to a less marked extent. Soda passes into the blood much less quickly than potash, and is on that account less used for its direct action on the blood, and more used for its action on the stomach and bowels, in cases of acidity and heartburn, &c. (see Section III.), though it may be employed in such cases as the potash preparations are used for. The bicarbonate is the preparation in most use. The phosphate and hypophosphite of soda are found in the compound syrups of hypophosphites because of their value in general nutrition.

Lithia.

Carbonate of Lithia	Dose, 3 to 6 grains.
Citrate of Lithia	,, 5 ,, 10 ,,

Lithia increases the alkaline character of the blood like soda and potash. Its special property, however, is the readiness with which the compounds it forms with uric acid dissolve. Now, excess of uric acid in the blood is supposed to be the cause of gout, and lithia is, therefore, given to ward off a threatened attack by removing the uric acid by the way of the kidneys, and to relieve an attack already begun. Deposits of uric acid in the kidney and bladder produce gravel—stone—and so lithia is given to dissolve the deposits and prevent the accumulation ever reaching the actual proportions of stone.

Magnesia and lime belong to the same class of remedies as potash, soda, and lithia, but as they are mainly used for their action on the digestive organs, they are noted in the section devoted to a consideration of the remedies that act on the digestive system.

As the natural alkaline character of the blood is increased by the use of potash, &c., so it might be to some extent diminished by the use of acids. They are not usually employed, however, to produce this effect, and they will be more suitably considered in the section on remedies acting on the digestive system.

Remedies which Cool the Blood—Antipyretics.

We are using rather a rough phrase when we speak of remedies which cool the blood, but the sense in which it will be understood is sufficiently accurate. We take quinine as the type of these substances, and it has been already pointed out that quinine prevents the ready yielding up by the blood corpuscles of oxygen to the tissues, and so diminishes the process by which heat is produced, and thus actually a cooling action results. This effect is chiefly obtained when the heat of the body is above the proper standard, when fever is present. Substances which diminish fever are called **antipyretics**, from the Greek *anti*, against, and *puretos*, fever. **Antifebrile** is a word with a similar meaning, and **febrifuge** also. Another word applied to medicines used for a like purpose is **antiphlogostic**, from the Greek, *anti*, and *phlogōsis*, burning heat. Besides quinine, there are several other substances which diminish fever—salicine, antipyrin, antifebrin, kairin, &c., although the manner in which they act is not well understood. Besides the administration of such drugs, there are other means of lowering the temperature of the body, which will, therefore, be rightly counted as means of antipyretic treatment. Chief of these is the use of the cold bath, which acts by the direct abstraction of heat from the body. Other methods consist in acting upon the skin, so that the blood-vessels of the skin are dilated, more blood comes to the surface, it becomes thereby cooled, and the skin glands become more active, the increased perspiration which results leading to increased loss of heat. This effect is produced by alcohol and by digitalis. Then the kidneys may be stimulated to separate more urine, and thus increase the loss. While numerous other substances, such as aconite, veratrum, and so on, so depress the activity of the tissues that less heat is produced, and the rate of loss remaining the same, the body becomes cooled.

In this section we propose to consider only a few drugs, such as quinine, salicine, and antipyrin, which speedily lower fever heat in a special way not yet well understood. It is to be noted that these drugs, while they reduce or remove fever, have usually no effect upon the natural temperature of the healthy body.

Quinine is obtained from the bark of the cinchona tree, found in Peru, Bolivia, and Columbia, growing on the Andes, chiefly on the eastern face of the Cordilleras, at a height of from 4000 to 12,000 feet above the sea-level. The trees are now successfully cultivated in India, Java, Ceylon, and Jamaica. There are three chief kinds of cinchona, the pale cinchona, the yellow cinchona, and the red cinchona. The yellow cinchona (*Cinchona Calisaya*) is the richest in quinine, the red bark (*Cinchona succirubra*) contains it also, but the pale cinchona (*Cinchona Condaminea*) yields chiefly a substance called **cinchonine**, whose properties resemble those of quinine.

The Yellow Cinchona bark is the most important. It is obtained in quills or flat pieces of a tawny yellow colour. Reduced to powder it is sold under the common name **Peruvian Bark**, of cinnamon-brown colour, aromatic and bitter taste. The powder is not now much employed. The dose is 20 to 60 grains or more, but it contains tannin, and therefore produces an astringent action, and much of it is useless woody fibre. Moreover it is not so readily tolerated by the stomach, and since the desired effects can be got out of a very much smaller dose of quinine, the powdered bark is little employed.

Its preparations are:—

	DOSE.
Decoction of Yellow Bark.........	1 to 2 fluid ounces.
Liquid Extract of Yellow Bark...	10 ,, 30 drops.
Infusion of Yellow Bark...........	1 ,, 2 fluid ounces.
Tincture of Yellow Bark..........	½ ,, 2 tea-spoonfuls.

The Pale Cinchona occurs in quills, with a whitish, yellowish-white, or ash-gray coating. Its powder is pale brown. Its only preparation is:

Compound Tincture of Pale Bark....Dose, ½ to 2 tea-spoonfuls.

Besides bark, the tincture is made of bitter-orange peel, serpentary, saffron, cochineal, macerated in proof spirit.

The Red Cinchona is found in flat pieces, less frequently in quills, reddish-brown on the outer surface; its powder is red-brown. Tincture, liquid extract, &c., may be made of it, as of the yellow bark, the doses being the same. Tincture of the red cinchona bark has been very highly recommended in America to allay the craving for drink in habitual drunkards. It is given in tea-spoonful doses (see p. 105).

The cinchona barks contain four highly complex chemical substances, called alkaloids, namely quinine, quinidine, cinchonine, and cinchonidine; they also contain acids and a volatile oil.

Quinine is obtained from the bark by maceration with weak hydrochloric acid, and then adding a solution of soda, which precipitates it. The powder is then washed, dissolved by dilute sulphuric acid, and allowed to crystallize out of the solution, so that it is the sulphate of quinine that is usually obtained.

Its preparations are as follows:—

Tincture of quinine...............Dose, 1 tea-spoonful and upwards.
(Each tea-spoonful contains 1 grain.)
Quinine Wine....Dose, 2 table-spoonfuls and upwards.
(Made with 1 pint of orange wine, 20 grains of quinine, and 30 grains of citric acid. An ounce, or two table-spoonfuls, contain 1 grain.)
Quinine Pill.................Dose, 3 grains and upwards.
(Each 3-grain pill contains 1 grain of quinine.)

Actions and Uses of Quinine.—Quinine acts on the stomach as a bitter tonic, when taken in small doses (½ to 1 grain), aiding the appetite and digestion, and being thus useful in states of general weakness, and in convalescence from acute disease. In large doses it may irritate the stomach and cause loss of appetite and sickness. It is its action on the blood with which we are here concerned, which, as already described, chiefly consists in binding the oxygen more firmly to the red blood corpuscles, and so preventing oxidation changes in the tissues, and lowering the heat of fever. For this purpose it requires to be given in large doses, 5 or 10 grains or even more, repeated if necessary. Such large doses produce peculiar effects on the nervous system, singing in the ears, deafness, a feeling of tightness in the head, giddiness, sometimes headache, and impairment of sight. By very large doses delirium is produced, and death might be caused, sometimes with convulsions. To these effects the term **quinism** or **cinchonism** is applied. In large doses quinine also weakens the heart, and slows the breathing. It is expelled from the body by the urine, and may irritate the bladder and urinary passage. It may stimulate the pregnant womb, and should, therefore, be given cautiously in this condition, lest miscarriage result.

Its most valuable effects are produced in such fevers as ague, and malarial fevers of all kinds, and in typhus fever, enteric fever, and fever due to blood-poisoning of other kinds. For ague, as a preventive, it is given in doses of 3 or 4 grains three times a-day, or, just before a fit is due, a single dose of 10 grains is best. For other fevers a single large dose may be given (10 grains or more) and repeated once in twenty-four hours, only if necessary, or two smaller doses (5 grains) may be given within one hour.

The influence which it has on fevers, recurring at definite periods—its **anti-periodic effect**, as it is called—extends also to other periodic affections, such as a neuralgia which tends to recur daily at a particular time. This may often be prevented by giving a 5-grain dose an hour or so before the usual hour of attack. Neuralgic headache it relieves, and with all the more certainty if it is combined with 20 grains of salicine.

Quinine, by a similar action to that which it exerts in preventing oxidation, prevents also fermentation, and it thus acts as an antiseptic, preventing the growth of minute organisms. Thus a dilute solution will preserve meat, milk, &c., for a length of time. On this account it is used as a gargle for ulcerated sore throat, and is added to tooth-powders.

The other substances named, cinchonine, &c., have similar effects but to a less extent.

Warburg's Tincture contains quinine with aloes, opium, rhubarb, camphor, and a number of aromatics, and is used for ague in doses of from one to four tea-spoonfuls.

Salicine is derived from the bark of the willow. It is also contained in poplar bark and in flower-buds of meadow-sweet.

Action and Use.—It reduces fever, and is specially employed in the treatment of rheumatic fever, being given in doses of 20 grains, repeated every two hours, till the fever abates and the pains disappear. When this has been accomplished, a powder should be given four times daily for several days to prevent a return of the attack. It is also very useful for neuralgia and neuralgic headaches, especially when combined with 5 grains of quinine.

Salicylic Acid may be derived from the oils of winter-green or sweet birch, but is usually derived from carbolic acid by heating with caustic soda and passing through it a stream of carbonic acid. It can also be obtained from salicine.

Its Actions and Uses resemble very much those of quinine. Thus, like the latter, it prevents putrefaction and decomposition, and is used largely for surgical dressings, for impregnating wool for surgical purposes. A mixture of 2 parts in 100 of tallow applied to the skin of the feet is useful in preventing sweating and soreness of the feet by walking. It is also employed as a lotion—4 parts to 100 of water—in irritation of the skin. Its internal effects are also like those of quinine, and produce like it noises in the ears, deafness, headache, and in large doses delirium. Like salicine it is used in acute and chronic rheumatism in doses of from 5 to 30 grains. But commonly a salt prepared from it, salicylate of sodium, is preferred.

Salicylate of Sodium..................Dose, 20 grains.
Used in the same way as Salicine.

Antipyrin is one of the most recent of the antipyretic class of drugs. It is a patented preparation, made in Germany.

Action and Use.—It causes profuse perspiration, and in suitable cases reduces fever with great rapidity. For adults the full dose is 30 grains hourly for three hours, but it may be given in smaller doses—10 grains—every half-hour, when the desired effect will usually be obtained after three or four doses, and further administration is withheld till the fever again threatens to rise, when the same process is repeated. It has a sweetish-bitter, peculiar, but not unpleasant taste, and requires a good quantity of water to dissolve it. In typhoid fever, and in blood-poisoning, in scarlet fever and other fevers, it is particularly serviceable, and it may be given to children in almost any feverish complaint, to the extent of 1½ grain for every year of the child's age, every hour for three hours. It may be sweetened for them. In the author's experience it is not so serviceable in reducing fever resulting from inflammation, such as inflammation of the lungs, inflamed tonsils, and the like. The influence of antipyrin on nervous headache is most surprising. The true nervous headache—megrim—will almost certainly be relieved within twenty minutes or half an hour by a dose of 10 or 15 grains. The person, after taking this dose, should if possible lie down in a quiet room. If relief is not begun, or is only slight, in twenty minutes, let a second dose be taken, and a third within other twenty minutes, if needful, and still a fourth, if required. If, however, these four doses fail to relieve, there is little use continuing the drug. In this drug, however, the person subject to periodic nervous headache, brought on also by the least excitement, shopping expeditions, &c., possesses a medicine that, in the author's experience, very rarely fails.

Thallin, used for fever in 5-grain doses, does not appear to be so good as antipyrin.

Antifebrin reduces fever quickly, and maintains the lower temperature for from three to seven hours, according to the quantity given. The dose is from 4 to 15 grains, not more than 30 grains being given in twenty-four hours. It slows the pulse, and often causes the patient to fall into a quiet sleep. In fevers generally, and specially in typhoid fever, rheumatic fever, and erysipelas, it is employed.

Kairin has a marked effect on fever, given in doses of from 3 to 30 grains. It is recommended that doses of 8 grains should be given every hour for four times or till the temperature has fallen to 100° Fahr. If the four doses have thus reduced the fever, 4 grains should be given every hour, should it appear necessary, but if the fever again rises, the larger dose is again given. It produces great sweating.

MEDICINES WHICH ACT ON TISSUE CHANGE.

Alteratives.

Alteratives, as already explained (p. 816), is the term applied to the drugs we are now about to consider, which improve the nutrition of the body by altering or modifying the chemical processes going on within the tissues, without producing any very perceptible action upon any organ or tissue in particular. The chief of these drugs are the metals, arsenic, mercury, iodine, and phosphorus, sulphur, and certain vegetable drugs, sarsaparilla, colchicum, guaiacum, &c. How these remedies act is not understood. They act slowly, without any apparent influence on the circulation, on the breathing, &c., and yet in time their effects appear. Their influence is brought to bear in the region of minute chemical change, at present beyond the reach of accurate scientific investigation. In time, however, the fact that they operate specially upon particular organs, though their modes of acting on these organs is unknown, becomes apparent. Thus arsenic specially influences the nutrition of the skin, mercury and iodine act specially upon glands and upon the nervous system, and so on.

Arsenic.—The chief preparations of arsenic are as follows:—

	DOSE.
Arsenious Acid (White Arsenic)	$\frac{1}{60}$th to $\frac{1}{24}$th grain.
Liquor Arsenicalis (Fowler's Solution)	2 to 5 drops.
Arseniate of Iron	$\frac{1}{10}$th to $\frac{1}{8}$th grain.
Donovan's Solution (Solution of Arsenic, Iodine, and Mercury)	10 to 30 drops.

Precautions in the Use of Arsenic it will be well to note first. As everyone knows arsenic is a powerful poison. Two grains of metallic arsenic have proved fatal, even when their administration was prolonged over five days. This quantity was taken as Fowler's solution, half an ounce of which it represents. Therefore arsenic should never be taken unless the dose and the manner of taking it is regulated by proper medical advice.

Arsenic should never be taken on an empty stomach, as it is very apt to produce irritating effects upon the stomach and bowels. It should, therefore, be taken only immediately after meals.

Arsenic should be taken only in very small doses to begin with. An ordinary dose of 5 drops of Fowler's solution given three times daily will produce, in many people, signs of irritation of the stomach, squeamishness, white silvery tongue, &c., whereas if a dose of 2 drops be given as frequently for several days, then 3 drops for a day or two more, and thus gradually the dose increased till the desired amount is reached daily, 12 to 30 drops, a tolerance will be established, and no signs of irritation produced.

When arsenic has been taken for a considerable period its use should not be suddenly stopped. A person who has been taking arsenic, in full doses, for a lengthened period, is likely when the need for it has disappeared to stop it all at once, as in the case of most drugs. This is a mistake. The sudden complete stoppage is apt to be followed, within even a few hours, by sickness, vomiting, headache, &c. Its use should be gradually stopped, even as it was gradually begun.

Arsenical Poisoning.—The symptoms of poisonous effects of arsenic are stomach pain, want of appetite, sickness, vomiting, diarrhœa, headache, silvery-white tongue, irritation of the eyes, and redness and swelling of the eyelids. If these symptoms arise in the course of using the medicine, the dose should be lessened; this is preferable to stopping the drug all at once. These symptoms are common in cases of chronic poisoning from the inhalation of vapour or dust containing arsenic. This used to be quite frequent, from the use of arsenic in the manufacture of wall-papers, to secure a brilliant green, and also from the wearing of articles of clothing, dyed with colours containing arsenic (see p. 732). This subject is considered at greater length in the next part, in the section devoted to poisoning.

Action and Uses of Arsenic.—Arsenic has a local effect upon the skin, used in the form of arsenious acid, which is for this purpose made up into a paste. It is employed to destroy growths. Its irritant action, when very mild, is occasionally made use of for stimulating the stomach. For this purpose very small doses are used, with the effect of aiding the appetite in certain kinds of indigestion. It is not, however, much employed for this purpose. Arsenic enters the blood and combines with the blood-corpuscles. It is sometimes used alone, or combined with iron, for bloodlessness—anæmia. It also is taken up from the blood by all the tissues and organs, remains in them for a short time, and is then cast off, being thrown off from the body by the urine, and to a slight extent also by the bile and skin. During its sojourn in the tissues it influences their chemical changes, the effect, when the dose is not excessive, being of a tonic and invigorating character. The arsenic-eaters of Styria, who begin with small doses, and are at length able to swallow 5 grains of arsenious acid at a time, do not suffer apparently, once they become habituated to the use of the drug, but present the appearance of strong healthy persons, and live to an old age. They have improved colour, increased muscular energy, and are able to climb the Styrian mountains without the breathlessness common to other people. *Some, however, die in the attempt to acquire the habit.* But the effects noted are due to the influence of the drug on tissue change. Arsenic is used in certain cases of bloodlessness, combined frequently with iron. Thus Blaud's pill (see p. 817) with $\frac{1}{60}$th grain of arsenious acid may be obtained of druggists, or the Fowler's solution with dialysed iron may be employed. Arsenic ranks next to quinine for its value in ague and malarial affections, and in affections exhibiting well-marked periods of recurrence, such as recurrent headache, periodic neuralgia, &c., it is very valuable. It is, therefore, said to be an anti-periodic. It is also used in nervous diseases, such as St. Vitus' dance and epilepsy. Its greatest employment, however, is in diseases of the skin, specially chronic diseases of the skin, such as eczema (p. 318), psoriasis (p. 319), &c. It has a special action on the skin, influencing the nutritive processes going on in a marked way. Very often it is combined with iron for this purpose, Fowler's solution, for example, with the compound iron mixture (p. 817). For skin diseases the solution of Donovan is also employed, combining the action of arsenic, iodine, and mercury, a combination much employed in skin affections dependent on syphilis. Finally, in chronic forms of lung disease, and in the early stages of consumption, its value is admitted, probably because of an improved condition of nutrition brought about in the lining membrane of the air-cells and fine tubes of the lung.

Mercury (Quicksilver) is a drug employed in a variety of forms and for very many purposes. Although we are considering it here for its influence on tissues, and its effect in bringing about an improved condition of general nutrition, still it will be well to note all its various actions and uses, to avoid considering it partly in one section and partly in another, though its effects on the bowel and liver, when given as blue pill, or as the cooling or "teething powder," with which probably everybody is familiar, will be further noted in the section devoted to drugs that act on the digestive system (section III.).

The chief preparations of mercury are as follows:—

	DOSE.
Calomel (Subchloride of Mercury).......	$\frac{1}{2}$ to 5 grains.
Plummer's Pill (Compound Calomel Pill)	2 ,, 5 ,,
Gray Powder (Mercury and Chalk).....	3 ,, 8 ,,
Blue-pill	3 ,, 8 ,,
(The size of pill usually sold by druggists contains 5 grains.)	
Blue Ointment (Mercurial Ointment).	
Corrosive Sublimate (Perchloride of Mercury: very Poisonous)	$\frac{1}{24}$th to $\frac{1}{16}$th grain.
Donovan's Solution (see p. 822).	
Red Precipitate Ointment (Ointment of Red Oxide of Mercury).	
Citrin Ointment (Ointment of Nitrate of Mercury).	
Black Wash (Lotion of Mercury). Made by adding 30 grains of Calomel to $\frac{1}{2}$ pint lime-water.	

Action and Uses.—Mercury is largely used as an application in the form of ointment or lotion to the skin. In the form of blue ointment it is used to destroy vermin. A solution of the corrosive sublimate is one of the most destructive agents of minute organisms, which are the cause of putrefactions and fermentations of various kinds, and is largely used in medicine and surgery as an antiseptic. Yellow precipitate and red precipitate ointment are common applications to chronic inflammatory states of the eyelids, as stimulant remedies. Lotions containing mercury are employed for the same stimulating effect, and as washes for ulcers, and sores slow to heal; calomel as a dusting-powder is used for the same effects. But ointments of mercury are very frequently rubbed on the skin, not for any effect to be produced on the part, but because they are absorbed from the skin into the blood and thus carried into the system. This method of administering the drug is called inunction. The usual course is to take a piece of blue ointment the size of a small bean and rub it well into the skin, in a situation where the skin is soft, such as the arm-pit or groin. This is continued daily till the effects of the drug manifest themselves. It is a method very applicable to children. A flannel bandage is put on the child, provided at one place with a small square pad, made of two or three folds of flannel, and sewed on the front part of the bandage. A small piece of ointment is smeared on this pad, and then the bandage is applied, the surface smeared with the ointment being next the skin. The bandage is fixed moderately tightly, and with the movement of the child the ointment is rubbed into the skin. Some newer preparations of mercury—the oleate of mercury ointment, for example—are more effective and active on the system than the old blue ointment, because they are more readily introduced through the skin. The usual method of administering mercury is by the mouth in the form of calomel, gray powder, blue-pill, solution of corrosive sublimate, or some of the more complex compounds of mercury, such as Donovan's solution, or the red or green iodides of mercury, compounds of iodine and mercury not named in the list given above. These substances are given by the mouth for one of two purposes: either to produce a purgative action and to influence the liver, or to be introduced into the system and to act upon the tissues generally. According to the effect desired is the form of drug prescribed, for, if a purgative action is produced, the most of the drug passes off in the motions and little enters the system. For the purgative effect calomel, gray powder, and blue-pill are commonly used. In the last two mercury is present in a metallic state, in a state of very fine subdivision. They appear to produce a purgative action by their local effect upon the stomach and bowels. They irritate the upper part of the small bowel, where the bile-duct from the liver enters (see p. 142), and thus cause the bile to be poured out of the liver into the bowel, although it would appear that mercurial preparations do not actually cause the liver to prepare more bile from the blood than it would otherwise do. They cause the liver, however, to deliver up its bile, so to speak, and then it is rapidly passed down the bowel by the quickened action of the bowel and expelled before much of it can be reabsorbed into the blood. A saline purgative, say a seidlitz-powder, given a few hours after a blue-pill, will thus aid its action by producing a flow of watery material into the bowel to wash it out more effectually. This is the reason for a blue-pill at night being followed by a seidlitz-powder in the morning. Gray powder is the form in which mercury is administered to children, for looseness of bowels, accompanied by the passing of greenish or curdy motions. While in many cases it is the appropriate remedy, it is given far too frequently and far too indiscriminately.

When the effect of mercury upon the system is desired, either some means is taken to prevent the purgative action of the calomel or blue-pill, or other preparations of mercury with less of a purgative action are employed, and especially the solution of perchloride of mercury (corrosive sublimate).

The action of mercury on the system is profound, though obscure. It is taken up from the blood by every organ of the body, and specially by the liver, and it may remain in them for an indefinite period, so as to be detected in them after death. During its residence it influences in some unknown way the minute nutritive changes going on. It is removed from the body in the urine, bile, sweat, and is found in the saliva from the mouth and in the milk. Its most marked effects are shown as the result of the alterative action on the tissues. Thus organs which are the seat of inflammatory deposits or overgrowths are very often rid of the abnormal state of things by a prolonged use of mercurial treatment. In no disease is this so marked as in those dependent upon the syphilitic poison, attended by the multiplication of small cells among the tissues, specially of the nervous system and skin, little tumours being in time formed which by pressure on nerves, &c., produce paralysis and the multitudinous kinds of symptoms seen in this disease. The action of mercury, when appropriately and timeously given, is to dissipate these growths and effect a cure. It is also employed to aid the absorption of inflammatory thickenings, not necessarily syphilitic, as for example such as result in the cavity of the belly from peritonitis (see p. 190).

Precautions in the Use of Mercury.—When mercury is given in excessive doses injurious effects speedily show themselves. The first part of the body to suffer is usually the mouth. The gums become tender, red, and swollen; an unpleasant metallic taste is felt in the mouth, which is also hot. The breath is foul, the tongue thickly coated, and the appetite gone. The flow of saliva is increased and the glands at the side of the face enlarge and are painful. If the use of the drug is continued, ulcers form in the mouth, the tongue becomes swollen so that the person cannot speak, the teeth become loose, and chewing becomes impossible. There are also chilliness, a feeling of general depression, and perhaps vomiting, purging, and bloody stools. **Mercurialism** is the term applied to these effects; and the action on the salivary glands, resulting in swelling and the constant dribble of saliva from the mouth, is called **mercurial ptyalism.** In very bad cases death of part of the jawbone may occur. When persons are exposed to the action of mercury in small doses for a long time, another kind of effect may be produced, a condition of general enfeeblement, thinness, pallor, dyspepsia, muscular tremors and rheumatic pains, tendency to fainting, and palpitation, and impairment of sight and hearing may occur. This kind of symptom has been found in those exposed to the fumes of mercury in certain manufactures. Many persons are more liable to the influence of mercury than others. Even a single grain of calomel has been known to produce in an adult all the marked symptoms connected with the mouth. Persons cannot, therefore, be too careful in dosing themselves with mercurials, and it is very curious how often one meets with persons who have pronounced objections to be treated with what is vaguely called "metallic remedies," with whom the use of blue-pill at regular intervals is yet almost a passion, and whose children are dosed, on the smallest excuse, with "cooling powders" or the like. These persons are very much astonished to learn that blue-pill and gray powder are formed of metallic mercury very finely divided up. The marked effects of a debilitating kind shown on excessive use of the drug, or in persons very susceptible to its action, exist to a modified degree even when the dose is not excessive, and must be met by the administration of good food and by strict attention to the conditions of health, fresh air, &c.

Iodine is obtained chiefly from kelp, the ashes of sea-weed, and it is present in sea-water.

Its preparations are as follows:—

Liniment of Iodine. }
Liquor of Iodine. } These are used for external application.
Tincture of Iodine. }
Iodine Ointment.
Iodide of Potassium................Dose, 2 to 10 grains.
Syrup Iodide of Iron............... ,, 20 to 60 drops.
(60 drops contain 4½ grains Iodide of Iron.)

Actions and Uses.—Iodine is used externally for its powerful irritant action on the skin and mucous membranes, being applied for its stimulating property and also for a disinfectant property to foul and discharging sores. It is also applied to the healthy skin for the purpose of acting on it much as a blister does, and so to bring the blood to the surface and relieve deeper parts. Thus it is often painted over the skin of inflamed joints after the acute inflammation has passed, for the removal of thickening, &c., in the joint, and on the chest following pleurisy and inflammation of the lung, to promote absorption of fluid or inflammatory products. It is used on the skin over enlarged glands, *when there is no active inflammation going on in the gland.* In the case of joints and chest affections, blisters are, in the author's opinion, much more useful, and in the latter case better results are obtained, without staining and injury of the skin, by the internal use of iodide of potassium or syrup iodide of iron. The preparations used for external application are the liniment, the liquor tincture and ointment. The liquid preparations are most commonly diluted with glycerine. It is injected in the form of tincture into the sac of a hydrocele to prevent reaccumulation of fluid, and for a similar purpose in spina bifida (p. 457). When administered internally, the preparation of iodine enters the blood and passes to all the organs of the body. It is expelled from the body with great rapidity, specially in the urine, but it also appears in the secretion from the nostrils, in the sweat, in the saliva and in milk, and it may irritate the organs chiefly concerned in separating it, specially the nostrils, salivary glands, and skin. When the irritation is marked symptoms, classed together under the term **iodism**, are produced. The chief of these are running at the eyes and at the nose, pain in the forehead, and sensations connected with the nose and forehead resembling those of a common cold. There are also tenderness of the gums and mouth, increased flow of saliva, a feeling of rawness in the chest, and perhaps loss of appetite and sickness, and there is increase of mucus from the air-passages. A skin eruption occurs with some persons. While iodine is found in all the tissues of the body, it is found particularly in lymphatic glands, and secreting organs, salivary glands for example. Its most common employment is because of the effect it produces on these organs after prolonged use. In the case of thickening and enlargement of the glands, it produces absorption of thickenings; and, after a long time, it may even cause a wasting (atrophy) of the glands themselves. Indeed the quickening effect it induces on tissue change is taken advantage of to promote the absorption of effusions of fluid and inflammatory thickenings in any part of the body, but specially in connection with joints, and the cavities of the body. Thus it is frequently employed to aid the removal of the fluid in pleurisy, and other dropsies, and the inflammatory products in inflammation of the brain, water-in-the-head, &c. In scrofulous affections of glands, and scrofulous thickenings in general, it is invaluable, the best form for children being the syrup iodide of iron. In the later manifestations of syphilis, particularly its nervous manifestations, it is largely resorted to. The intense and continuous headache and the night pains of syphilis yield in a surprising manner to iodide of potassium, which is, in this instance given in large doses, 30, 60, and even 90 grains daily, if it can be borne, for it is a remarkable circumstance that large doses, 10 grains and upwards, are borne more readily than small ones, 2 to 5 grains.

Iodine forms easily-dissolved combinations with lead and mercury, and therefore it is administered in cases of chronic lead and mercury poisoning, for the sake of combining in the tissues with these metals and so securing their removal from the body. It is used in chronic rheumatism, and in large doses in aneurism.

Care should be taken that anyone being treated with iodide of potassium or iodine in other forms has abundance of easily-digested and nourishing food.

Phosphorus is obtained from bone-ash, in which it exists combined with lime.

Its principal preparation is:

Phosphorus Pill..........Dose, 1 to 3 grains, containing $\frac{1}{90}$ to $\frac{1}{30}$ grain of phosphorus.

Actions and Use.—Phosphorus has a marked effect on tissue change. In very small doses, given for a long time, it has been shown to act upon bones, increasing the amount of dense bone formed. In larger doses it leads to fatty degeneration of tissues, and, in cases of poisoning by phosphorus, extensive fatty change of liver, muscles, heart, and other organs is found. This is due to albuminous substances being broken down into a nitrogenous and a fatty portion, and the fatty portion being prevented uniting with oxygen. Phosphorus is administered in cases of nervous disease, nervous debility, neuralgia, paralysis, sleeplessness, being given as pill, or in combination with other drugs, such as zinc, with which it forms phosphide of zinc, of which the dose is $\frac{1}{6}$th to $\frac{1}{3}$d grain in pill. Then it is a common ingredient in the various compound syrups, used for general debility, lung diseases, and so on, in the form of phosphate of lime, or hypophosphite of lime, soda, &c.

Sulphur.—The principal preparations of sulphur are:—

Flowers of Sulphur (Sublimed Sulphur)..............................Dose, 20 to 60 grains.

Confection of Sulphur, or Sulphur Electuary: Flowers of Sulphur, 4 oz.; Cream of Tartar, 1 oz.; Syrup of Orange Peel, 4 oz. This is the same as the time-honoured "sulphur and treacle," treacle or ordinary molasses syrup being used instead of syrup of orange peel.....Dose, 1 to 2 tea-spoonfuls.

Sulphur Ointment (Flowers of Sulphur, 1 oz.; lard, 4 oz.).

Chrisma Sulphur.

Milk of Sulphur (Precipitated Sulphur)...............................Dose, 20 to 60 grains.

Action and Use.—Sulphur is used as a local application in the form of ointment for skin diseases, and in particular for such as depend on parasites, such as itch. It appears that it is not the sulphur, as such, which is of value, but, in contact with the skin, compounds of sulphur are formed, namely sulphurous acid and sulphuretted hydrogen, which are destructive to the life of minute organisms. Sulphurous acid is liberated, as a gas, when sulphur is burned, and is liberated thus for purposes of disinfection; and sulphuretted hydrogen is also a gas, of nauseous foul smell. The smell of rotten eggs is due to the presence of sulphuretted hydrogen, produced from the decomposition of the albumin of the egg, for albumin contains sulphur in combination. Sulphurous acid in solution has been employed as a paint or spray for the throat in diphtheria, in the hope of destroying the fungus of the diphtheritic membrane, and sometimes with apparent success.

When sulphur is taken internally it stimulates the bowel and produces, without pain, an easy soft stool. It is, therefore, used as a laxative whenever there are conditions of the bowel, or neighbouring organs, in which more active purgatives would do harm, in cases of piles, for example, and pregnancy, &c. For this purpose the sulphur electuary is most valuable. Sulphur waters, such as those of Moffat and Strathpeffer in Scotland, Harrogate in England, Aix-la-Chapelle, Aix-les-Bains, Eaux-Bonnes, and others abroad, are used for similar purposes, as well as for other effects to be noted. These waters contain sulphur in the form of sulphuretted hydrogen or as salts, like sulphide of potash, &c. Sulphur when taken internally enters the blood as sulphuretted hydrogen, or salts, and is expelled from the body in the urine, and also by the breath and sweat. The breath may have the disagreeable smell of sulphuretted hydrogen on that account, and any silver articles worn about the person, silver coins carried in the pocket, &c., will be blackened by the sulphur excreted by the skin. In large quantities the sulphur compounds named act upon the nervous system in a depressing way, and it is perhaps owing to this that sulphur waters produce headache and depression on some persons. Having entered the blood the compounds reach the tissues, and modify their action in some unknown way. Because of this action, they have gained a repute in chronic rheumatism, gout, syphilis, and skin disease; while because of the laxative effect of sulphur waters, they are largely resorted to by those suffering from constipation and liver disorders.

Within recent years, Dr. Bergeon, of Lyons, has advocated the treatment of consumption and other lung diseases by injecting into the bowel carbonic acid gas, charged with sulphuretted hydrogen. A special apparatus has been designed for the purpose. It consists of a wide glass bottle in which a solution of soda is placed. To this is added tartaric acid. Carbonic acid is produced in large quantity, and is carried by a tube, guarded by a valve, to an india-rubber bag. From this bag a tube leads to a bottle containing a sulphur water, such as Eaux-Bonnes, or a solution of a sulphide from which sulphuretted hydrogen is liberated by the addition of a little of a solution of tartaric acid. The tube from the bag pierces the cork and dips down below the surface of the solution. The cork is pierced by another tube, which terminates, however, just inside the bottle, and this tube communicates with an elastic bag, similar to that of an enema syringe. From the other end of this elastic bag a tube passes off, the end of which is of a kind fitted for passing up into the bowel. When the elastic bag is squeezed any gas it contains is forced into the bowel, and when the pressure is relaxed carbonic acid gas is drawn into it from the india-rubber reservoir, bubbling through the solution of sulphuretted hydrogen on its way. The sulphuretted hydrogen is absorbed by the blood-vessels of the bowel, carried through the liver to the right side of the heart, and thence to the lungs, from the air-cells of which, according to Bergeon, it is expelled. His view is that as it thus passes through the lung tissue, it exerts an action upon the organisms of consumption destructive to their activity, a disinfectant action, and produces a healing influence on the diseased parts of the lung. The treatment has been highly praised abroad, and some good results have been said to follow its use by English physicians. It is only, however, in the early stages of the disease, and in slow chronic cases, that its beneficial effect is found, and it does not seem to retard at all the progress of acute cases, cases of galloping consumption. This latter fact the author has verified, as in a few cases of this kind in which he was able to have the method daily employed for many weeks, no benefit followed. The process of injection is somewhat tedious, half an hour to one hour being required each time; and it should be done certainly once, and, if possible, twice daily, about 2 pints of gas being injected each time. The bowel is thus filled with gas, and considerable discomfort is at first produced, aggravated by an almost unavoidable resistance on the part of the patient. After a little experience, however, the discomfort is readily borne, resistance ceases, and the injection becomes very much easier. The process can be easily performed by a nurse, or anyone of average intelligence, after the method has been seen in action once or twice, so that after a day or two of practice the patient's friends can themselves carry out the treatment readily.

Sulphuretted hydrogen is a poisonous gas, and if inhaled in sufficient quantity will cause death by suffocation. Accidents of this kind have occurred to men entering cesspools for cleaning purposes, when they have been charged with the gas from decomposing materials. The breathing of air containing any quantity of the gas produces loss of appetite and headache in most people. In the use of the injection for consumption, therefore, the bottles should be kept well corked to prevent escape of the gas into the apartment, and if the gas is being expelled from the bowel, almost as soon as it is injected, one should proceed slowly till the bowel gets accustomed to the treatment, or stop altogether for a time. It is a remarkable fact that injurious effects from the gas are never produced on the patient, the explanation offered being that all the gas absorbed from the bowel passes into the venous system, and that the blood passing through the lung before it is distributed through the body is freed of the gas, which thus never reaches the tissues, and has no opportunity of exerting a poisonous effect.

Sarsaparilla is the dried root of a Jamaica plant.

Its preparations are:

	DOSE.
Decoction of Sarsaparilla	2 to 10 fluid ounces.
Compound Decoction of Sarsaparilla	2 ,, 10 ,, ,,

(Made of 2½ ounces Jamaica sarsaparilla, cut into pieces, sassafras in chips, guaiac wood turnings, and fresh liquorice root, bruised, of each ¼ ounce, mezereon, 60 grains, boiling distilled water, 30 ounces, evaporate to a pint.)

	DOSE.
Liquid Extract of Sarsaparilla	½ to 4 tea-spoonfuls.

Sarsaparilla had, of old, a high repute in the treatment of blood disorders, and especially in the treatment of syphilis, chronic diseases of the skin, gout, scrofula, and rheumatism. It is now practically neglected by most physicians, though as a domestic remedy it is still thought highly of. It appears to stimulate the skin and kidneys. It is given also along with iodide of potassium, and the beneficial effects it was believed to have on the system generally are supposed to be mainly due to such drugs combined with it.

Colchicum or Meadow Saffron yields several preparations, used in medicine, and derived either from the sliced corm or bulb, or from the fully ripe seeds.

Preparations:

	DOSE.
Extract of Colchicum (from the bulb)	1 to 3 grains.
Extract of Colchicum with Acetic Acid (from the bulb)	½ ,, 2 ,,
Wine of Colchicum (from the bulb)	10 ,, 30 drops.
Tincture of Colchicum (from the seeds)	10 ,, 30 ,,

Action and Use.—Colchicum increases the quantity of bile expelled from the body, and also causes an increase of perspiration. When the dose is too large it irritates the stomach and bowels, producing vomiting and purging, and great prostration. The heart is weakened, and breathing diminished, and the nervous system is depressed. Its main use is in gout, in acute attacks of which it is regarded as almost infallible, though it sometimes fails to afford relief. It markedly relieves the inflammation and pain, for which purpose ½ to 1 tea-spoonful of the wine may be given. It has been shown that while it does this, the effect produced is temporary, as the drug does not relieve the system of the cause of gout, the excess of uric acid in the blood and tissues, and, therefore, does not prevent a return of the attack. Thus the use of drugs such as lithia and potash which remove the uric acid are preferred, and "gout-ridden sufferers commonly advise their fellow-sufferers to abstain from colchicum." It is said to act best when administered with medicines, such as sulphate of magnesia (the ordinary "salts"), which produce a purgative action.

Guaiacum is used as a wood—*lignum vitæ*, and as a resin obtained from the tree stem.

From the resin the following are made:—

Guaiac Mixture................Dose, 1 to 1½ fluid ounce.

(Made of powdered guaiacum, ½ ounce, sugar, ½ ounce, powdered gum arabic, ¼ ounce, cinnamon water, 1 pint.)

Ammoniated Tincture of Guaiacum.....................Dose, ½ to 1 tea-spoonful.

Action and Use.—Guaiacum stimulates the lining membrane of the mouth, throat, and stomach, when taken internally, producing a feeling of heat in the mouth and stomach, and stimulating the movement of the bowel, causing purging, in large doses severe vomiting and purging. It also stimulates the heart by nervous influence. Entering the blood it excites the skin and kidneys, the liver, and tissue change in general. It is highly spoken of in the treatment of sore throat, quinsy, for which it may be given in powder, 30 grains placed on the tongue and slowly swallowed, every six hours, or as the mixture, or in the form of lozenges, each of which contains 2 grains. In chronic rheumatism and gout it has been used with much success, the ammoniated tincture being advised.

Mezereum is the dried bark of *Daphne Mezereum,* or *Daphne Laureola,* the spurge laurel. In small doses it acts on the skin and kidneys, but in larger doses is a marked irritant, producing purging and vomiting. It is used in chronic rheumatism, scrofulous and skin disease, but is practically unknown in this country, except as an ingredient of the compound decoction of sarsaparilla (p. 828). As a liniment in combination with mustard and as an ointment it is employed externally.

Section II.—DRUGS WHICH ACT ON THE HEART AND BLOOD-VESSELS.

Drugs which Act on the Heart.

Heart Stimulants:
- *Ammonia*—Its Preparations and Use in Fainting;
- *Ether;*
- *Camphor;*
- *Alcohol*—How to Employ it as a Medicine.

Heart Tonics:
- *Digitalis*—Its Value in Weakness and Irregularity of the Heart;
- *Squills; Lily of the Valley* (Convallaria majalis);
- *Strophanthus hispidus.*

Heart Sedatives—Drugs which Soothe the Heart·
- *Aconite*—Cautions Requisite in its Use.

Drugs which Act on the Blood-vessels.

Drugs which Contract the Blood-vessels:
- *Ergot of Rye*—Its Use in Internal Bleeding;
- *Witch-Hazel* (Hamamelis virginica);
- *Acetate of Lead.*

Drugs which Relax the Blood-vessels:
- *Nitrite of Amyl*—Its Employment in Asthma.

Anyone who reads the 8th Section of the First Part of this work with understanding will appreciate the primary importance of a healthy condition of the blood, by which all the tissues and organs are maintained in a condition of activity, and will perceive the paramount necessity of the blood being distributed to the whole body with due regularity and in sufficient amount. It will matter little that the blood is of excellent quantity if it does not reach the tissues in a regular stream, nor will the body as a whole exhibit the evidences of a general well-being, if the blood lingers in overcharged vessels in one organ, while another is half-starved from a defective supply. The dependence of the body, therefore, upon the condition of the heart, which supplies the motive power for driving the blood through the body, and of the vessels, which are the channels of distribution, is fully evident. Speaking broadly, disorder of blood distribution will depend upon one of two circumstances: either the force-pump, the heart, is working improperly—too feebly or too strongly or irregularly; or, while the heart is working properly, the vessels are the cause of disturbance—contracted in calibre it may be, and thus opposing too great resistance to the onward flow of the blood, or relaxed and permitting too free a flow in one direction or another, tending to create some local congestion, or other disorder; or, of course, some element of disturbance may exist in both. The study of remedies which can be brought to bear upon the heart and blood-vessels will, therefore, be one of much interest. We shall, then, consider some of the chief drugs which act upon the heart and vessels, and the objects which may be gained by their use.

DRUGS WHICH ACT ON THE HEART.

Drugs which act on the heart may be roughly divided into those which stimulate the heart, which brace or tone the heart, **heart tonics,** and stimulants, and drugs which quiet or soothe the heart, heart sedatives, or heart depressants.

Heart Stimulants and Tonics.

The heart is a muscular organ, the fibres of which are so arranged that, when they contract, the size of its cavities is diminished by a ringing or twisting movement, and the blood driven out into the vessels. If this movement be feeble, the heart will not be properly emptied with each contraction or beat, and the vessels will not be properly filled. The nutrition of the body will be imperfectly carried on. A good illustration of such a consequence, arising suddenly, is fainting or syncope. The heart is from some cause suddenly enfeebled, or its action almost arrested, and the brain being deprived of its needed supply immediately suspends its functions. If the cause be some momentary shock, the heart's beat is gradually restored, the circulation in the brain becomes re-established, and consciousness returns. Or if a stimulant be applied in some way to the heart so as rapidly to excite its activity, consciousness returns, and the colour returns to the face, pale from want of blood. Enfeebled action of the heart, whether brief, as in this case, or more long-continued because of some other condition, leads not only to failure of nutrition of the body, but also to defective nutrition of the heart itself. For the heart itself is supplied with blood by two arteries, the coronary arteries, which are the first branches to come off the main distributing vessel, the aorta (p. 223). So that if the heart is feebly propelling blood into the vessels, the heart is the first sufferer, and any long-continued feebleness will inevitably tend to perpetuate itself, because of the failure of the heart-substance to receive due nutrition.

Now the heart muscle may be stimulated directly, but is specially acted on, like other muscular organs, through the nervous system. Within the substance of the heart are nervous structures whose business it is to maintain the steady rhythmic movement of the heart. These may be acted upon and excited by remedies, administered and gaining access to the blood. These nerve ganglia, as they are called (for the meaning of ganglia see p. 85), are in turn controlled in their action by two nerves, the pneumogastric (p. 225), which restrains their action, so as to cause a slowing of the heart's beat, and, if excessive, a stoppage of the heart in a state of complete relaxation, and the sympathetic (p. 225), which excites them, and inceases the rapidity of the heart's action, leading, if excessive, to stoppage of the heart in a state of firm contraction. Acting, then, through one of these channels, stimulants increase the force and frequency of the heart's contractions.

Heat is one of the best and most rapidly acting of heart stimulants, whether in the form of a hot liquid taken into the stomach, or in the form of a hot sponge applied over the heart, or a hot-water bottle, similarly placed. It is exceedingly useful when it is necessary to act immediately, as in fainting or sudden collapse. It is drugs, however, we wish to consider specially, and the drugs which stimulate the heart are chiefly ammonia, ether, camphor, and alcohol.

Ammonia is a gas, used as a solution in water, from which it rapidly passes off. When one smells liquid ammonia, it is the gas coming off which produces the hot pungent sensation in the nostrils.

The chief preparations are:—

	DOSE.
Strong Liquor Ammonia	2 to 5 drops, well diluted.
The weaker solution to be preferred, if taken internally.	
Ammonia Water, or Liquor Ammonia	10 to 20 drops, well diluted.
Made with 1 oz. of the strong liquor to 2 ozs. of water.	
Sal Volatile, or Aromatic Spirit of Ammonia	½ to 1 tea-spoonful.
Liniment of Ammonia, Ammonia water, 1 oz.; olive oil, 3 ozs.	
Carbonate of Ammonia	3 to 10 grains.
Chloride of Ammonia	5 ,, 20 ,,
Solution Acetate of Ammonia (Mindererus' Spirit)	2 to 6 tea-spoonfuls.
Bromide of Ammonia (see Section on Drugs which Act on the Nervous System).	

Actions and Uses.—Ammonia acts as a stimulant to any surface to which it is applied. If applied to the skin it causes a hot burning sensation, and produces redness, and is, therefore, used as a liniment to rub over stiff joints, muscles, &c. If it is applied on a cloth and covered up, it will blister. But it is not usually employed for this purpose. It may be used to destroy the poison of snake bite, or to relieve the sting of insects and nettles—the weak solution. Raspail's sedative solution, used as a lotion for headache in women who suffer because of some womb derangement, is made with 2 ounces ammonia water, 2 ounces of common salt, 3 drachms camphorated spirit of wine, and 32 ounces of water. When applied to the nostrils as smelling-salts, or when the solution is sniffed (the weak solution should be used), the vapour of ammonia irritates the nostril, it excites the action of the heart, through the nerves, quickens the pulse, and also quickens the breathing. It should not be used for too long a time for this purpose. A solution of any strength ought not to be held beyond an instant or so under the nostrils of an unconscious person, as the irritating vapour might inflame the nostrils and even the lining membrane of the lung tubes and lead to bronchitis. Taken into the stomach, it acts there also as a stimulant, but if used very strong or in too large quantities may occasion inflammatory action, and even cause death by its powerful effect arresting the breathing. Given in proper doses it not only stimulates the stomach, and produces a sensation of warmth, but it stimulates the action of the heart, even before any has time to be absorbed and act on the heart through the blood. The carbonate is the best preparation to give for this purpose. Its action on the stomach and bowel makes it useful for colic and flatulence. Carbonate of ammonia in 5-grain doses, with 5 to 10 drops of tincture of cayenne, and an ounce of infusion of calumba or other bitter infusion, is recommended to relieve the craving for spirits, and as a stimulant in cases, specially in women, when feelings of sinking and depression are felt. Carbonate of ammonia has also been used in scarlet fever, to diminish the fever and delirium, and has gained high repute, being given in 3 to 5 grain doses every two or three hours. Besides acting on the heart, ammonia acts as a stimulant to the bronchial tubes, increasing the action by which matters are swept up the tubes, and is, therefore, very valuable for aiding the expulsion of matter from the lungs, as in bronchitis when there is much expectoration. Its effect on the heart makes it specially useful in such cases. Given in the form of solution acetate of ammonia, it acts on the skin as a stimulant, promoting sweating; and this is a very simple and harmless preparation to give to children in feverish complaints, to promote sweating and diminish the heat of the body. Chloride of ammonium has been largely used in chronic cases of liver congestion.

Ether is discussed in the section devoted to drugs acting on the nervous system, along with chloroform. It may be used in cases of urgency to excite the heart or to dispel wind in the bowels in nervous and hysterical women. Of the ether itself, 20 to 60 drops are the dose given diluted or injected into the bowel, or the spirit of ether in 30 to 60 drop doses.

Camphor is a volatile oil, obtained from the wood of *Cinnamomum Camphora*, and imported from China and Japan.

	DOSE.
Camphor	1 to 10 grains.
Preparations :—	
Camphor Water (Tie ¼ ounce crushed Camphor in a muslin bag, and leave in 4 pints of water for at least 2 days.)	1 to 2 fluid ozs.
Camphor Liniment (1 oz. camphor, 4 ozs. olive-oil).	
Spirit of Camphor	10 to 30 drops (in milk or on sugar).
Paregoric Elixir, Compound Tincture of Camphor (Contains opium.)	15 to 60 drops (for adults).

Actions and Uses.—Camphor stimulates the skin, and is therefore used for liniments and ointments to relieve stiffness of muscles and joints, for sprains, &c. It stimulates the stomach, and is useful for dispelling wind, specially in hysterical subjects; but in large doses it irritates the stomach and causes sickness and vomiting, with a burning sensation at the pit of the stomach. The stimulating effect on the stomach and bowels renders it most valuable in cases of summer diarrhœa, attended by cramp. It is recommended in the form of spirit of camphor, 4 to 6 drops, on sugar or in milk, every ten minutes till the improvement occurs, and in 1 or 2 drop doses it is given to children in milk in like disorder of the bowels. At the very beginning of a cold in the head, the sniffing of camphor, or taking a dose by the mouth, very often relieves. For its stimulating action on the heart it is resorted to in fevers producing prostration. It strengthens the pulse and moistens the skin, checking delirium. It also stimulates the nervous system, but in excessive doses produces great excitement and convulsions, and if the dose be very large may cause death.

Alcohol.—The question of alcohol has been already discussed sufficiently (see p. 668). In the form of whisky or brandy it is usually most frequently at hand in cases of fainting. To relieve or ward off a fainting attack a small quantity, strong, is better than when it is much diluted, for the stimulating effect of the strong spirit on the mouth and stomach excites the heart even before any has had time to pass into the blood. In weak conditions, whether whisky is having a beneficial effect or not upon the heart can be determined by the state of the pulse, skin, tongue, breathing, &c. If the quick hurried pulse of fever is steadied, and slowed, while made stronger, if the breathing is quieter and more regular, if the skin is more cool and moist, and the tongue less dry and parched, and sleep is induced, the alcohol is having a good effect. But if the pulse is more hurried, the patient more restless, the heat of the skin greater, it ought not to be continued. The effects it produces should be carefully watched for some time after a dose has been given to enable one to determine whether it should be continued or not. "Particular care should be taken in the administration of alcoholic stimulants to patients in the small hours of the morning. It is about this time that attendants are most apt to become sleepy, and therefore careless, and just at this time, also, the external temperature is lowest, the fire is apt to get low, and the vital powers of the patient are most likely to sink. In giving alcoholic stimulants to support the strength in disease, care must be taken that they are not given so frequently and in such large quantities as to disorder the stomach. Sometimes, when given very freely to support the failing circulation, they have this effect; the result of which is that both food and stimulants are vomited, and the patient may be brought to death's door." If whisky or brandy is found to be doing good the attendant is too apt to push its administration too far in the eagerness to secure the utmost advantage. This can only be avoided by a carefully accurate record being kept of the quantity used in 24 hours. It is not desirable to administer it in large quantities at long intervals, but in small quantities at short intervals. A very good way of accomplishing this is to give it in milk. Let a table-spoonful be mixed with a tumblerful of milk and kept covered, and let the patient receive sips of this every little while, every quarter or half hour, as may seem demanded. The quantity used in 24 hours is then counted as tumblerfuls of milk. A table-spoonful is $\frac{1}{2}$ oz. Now we have seen that, in health, 2 ounces of whisky or brandy is about the quantity that can be effectually disposed of in 24 hours, that would be 4 table-spoonfuls. But in disease very much larger quantities can be consumed without producing any sign of bad effects. Indeed children, even infants, can often take that quantity and above it, without being in the least affected by it. Larger quantities are, therefore, often demanded, specially in such cases as inflammation of the lungs accompanied by weak and failing action of the heart, bronchitis, and indeed in any diseases which imply a great strain upon the vital powers. It is remarkable how young children take this mixture of whisky and milk, and how often it seems to be the most beneficial thing to give in bronchitis with a great amount of material in the lungs, &c. For them the dessert-spoonful to each small teacupful of milk would be sufficient, and four or upwards of them might be used in 24 hours. Alcohol may often be replaced by such a stimulant as ammonia, but ammonia quickly passes through and escapes from the system, so that its action is short-lived, while the effect of spirits lasts for a considerably longer time, and can, therefore, be maintained more steadily and readily. Alcohol ought not to be employed in cases of nervous prostration, neuralgia, hysterical affections, sleeplessness. The risk of its use being continued, and continued to excess, and beyond the time of need, in all cases where the stimulant must be given for some time, or where the affection recurs at regular periods, is so great that it is better to seek some other means of producing the effect desired. In no class of cases is this more apt to occur than in women who suffer from nervous or hysterical attacks, or who are liable to regular periods of depression or pain at stated times. Every medical practitioner has met with cases where inveterate drunkenness has been traced to an illness when stimulants were given by medical orders, and when they were continued long after the order to give them was withdrawn.

Of **heart tonics** the chief are digitalis, squills, lily of the valley, and the most recent is strophanthus, the African kombé or arrow-poison.

Digitalis.—The leaves of digitalis, or the purple foxglove (see Plate XI.), are the parts of the plant used in medicine.

The preparations are:—

	DOSE.
Tincture Digitalis..................	5 to 30 drops.
Infusion of Digitalis	2 ,, 4 tea-spoonfuls (drachms).
Digitalin (the active principle)..	$\frac{1}{60}$,, $\frac{1}{30}$ grain.

Action and Uses.—Digitalis acts upon the heart by increasing the force of its beat and lessening its frequency. Its effect is thus of a tonic character. At the same time it stimulates the nerves acting on the blood-vessels, diminishing their calibre. The heart is thus emptied at each beat more completely, the arteries are better filled, and are kept so by their diminished calibre, and the circulation is thus made more effective. The feeble heart is strengthened, and in cases where the beat is irregular, now fast now slow, now strong now weak, an occasional beat being missed and this being followed by a series of short, quick, feeble, fluttering, beats, its effect in appropriate doses is most marked and beneficial. The great disadvantage of digitalis is its tendency to derange the stomach and bowels, to produce loss of appetite, heartburn, vomiting, and sometimes diarrhœa, an effect partly due to an irritating action on the lining membrane. This is one of the great difficulties in the use of the drug, for a patient cannot afford to have digestion deranged and disturbance of the first step in the nutrition of the body interfered with. In too large doses it produces irregularity of the heart's action, and poisonous doses cause death by stopping the heart. The drug has also a marked effect upon the kidneys, the result of which is greatly to increase the amount of urine passed.

The two purposes, then, for which digitalis is used are for affections of the heart, either when the heart is irregular in action from feebleness, when there is palpitation, or in certain cases of actual disease of the valves of the heart, and for cases of dropsy, because of its action on the kidneys. It is particularly serviceable in removing dropsical fluid by way of the kidneys, when the dropsy is due to bad circulation from some defect of the heart. It is useless to discuss here the kind of cases of heart disease in which it is useful, for in certain cases of heart disease, where the valves of the aorta (p. 239) are affected, it is held to be injurious. Whether it is likely to be useful or not is, therefore, a question for a skilled physician. It is in cases of weak irregular heart, unaccompanied by valve disease, specially in those well advanced in years, that its most marked effects are seen. One would begin with a small dose, 5 drops or so, thrice daily, and work slowly up, adding an extra drop or two daily till a steadying effect was produced, not going beyond 20 drops without great caution. In such cases sleeplessness is a very common symptom, and a marked degree of restlessness. This is due to the defective circulation, and often one of the first signs of marked improvement following the use of the drug is the passing off of the restlessness and sleeplessness, when the patient falls into a sound quiet sleep. The drug has a cumulative action, that is, it is not rapidly expelled from the body, and small doses continued for some time may suddenly lead to the production of unpleasant symptoms, sickness or faintness. In such cases the drug should be much diminished in dose. It must further be noticed that patients getting full doses of the drug should lie in bed; getting up on to their feet is apt to induce an attack of faintness.

Squills.—The squill is a pear-shaped bulb (*Urginea Scilla*) belonging to the lily order, and found growing along the shores of the Mediterranean. The bulb is sliced and dried for medicinal purposes.

Its preparations are:—

	DOSE.
Vinegar of Squill	15 to 40 drops.
Syrup of Squill (1 oz. vinegar of squill, 2 oz. sugar)	½ ,, 1 tea-spoonful.
Oxymel of Squill (5 oz. vinegar, 8 oz. honey)	½ ,, 1 ,,
Tincture of Squill	15 ,, 30 drops.
Compound Squill Pill	5 ,, 10 grains.

Actions and Use.—Squill acts upon the heart in a manner similar to digitalis. It is even more irritating to the stomach and bowels. Its common popular use is for cough, for which it is constantly given without judgment, in the form of syrup. It stimulates the lining membrane of the air-tubes, and increases the expulsion of phlegm and other matter. It is, therefore, useful in chronic bronchitis when the excretion is profuse, but not when active inflammation is going on. Its constant use, therefore, specially for children, ought not to be encouraged. It acts like digitalis upon the kidney, increasing the amount of urine.

Lily of the Valley (*Convallaria majalis*) resembles digitalis and squill in action on the heart and kidneys, and in its irritating effect upon the stomach and bowels.

Its preparations are the watery extract, of which the dose is 2 to 8 grains, and convallamarin, the active principle, of which the dose is ½ to 2 grains.

Strophanthus hispidus (*Kombé*) is one of the most recently introduced drugs, its employment being recommended, in certain cases of heart disease, by Professor Fraser, of Edinburgh, in 1887. The seeds are employed in Africa to yield an arrow-poison. Its chief preparation is:

Tincture of Strophanthus.......Dose, 2 to 5 drops.

Its action much resembles that of digitalis, being that of a tonic to the heart-muscle. It strengthens the beat of the heart and slows its frequency, the slowing action being sometimes very marked. It is used in certain cases of heart disease, but its action has not yet been sufficiently studied to enable one to say exactly under what circumstances it is useful. One advantage it seems to possess over digitalis is its less tendency to create sickness and irritation of the bowels, but in one case in which the author administered it in very large doses, severe cutting pains in the bowels occurred, apparently due to its action on the muscular wall of the bowel.

Heart Sedatives.

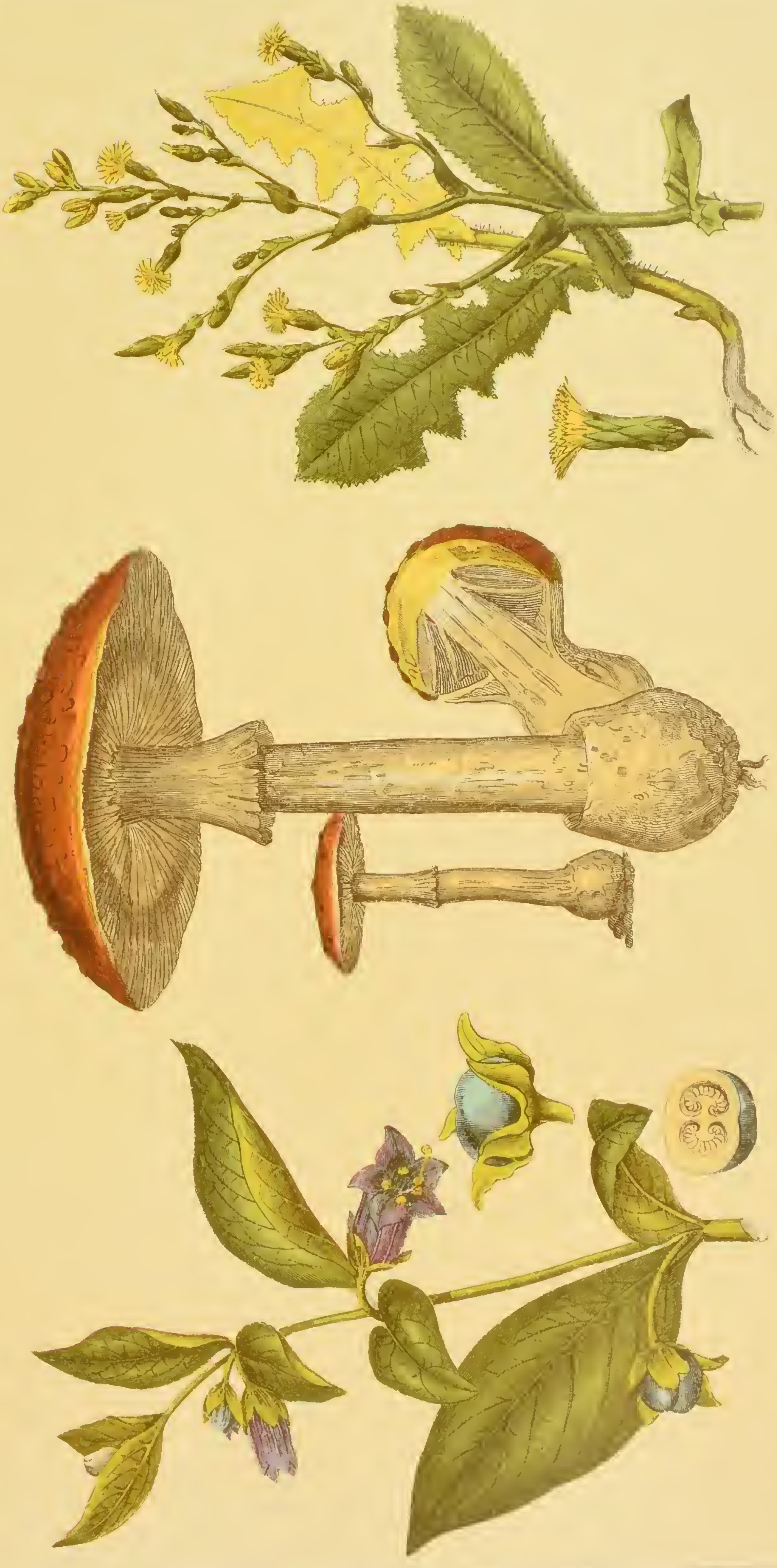
Drugs which soothe the heart, which diminish the force and frequency of its beat, are heart sedatives. In one way they act by weakening the heart's action, by depressing it. Sometimes they are employed for such purposes, for example, in cases of severe inflammation or high fever in strong persons. But they are not, just on that account, remedies to be used except by those whose knowledge enables them to form a correct judgment of their suitability, and whose experience qualifies them to watch that their effects do not pass beyond the production of the desired result, for they can easily produce a dangerous weakening of the heart. It ought further to be observed that often an irritable, palpitating, heart, which the inexperienced would imagine needed soothing remedies, requires really tonic treatment. In some such cases the heart is irritable and irregular, and the patient feels it thump and bound unpleasantly against the chest wall, because it is weak, because it needs strengthening, and then anything which would depress it would act more injuriously, whereas anything which would exert a toning action upon it, such as digitalis, would speedily relieve the symptoms. What has been said ought to be sufficient by way of caution against the use of such drugs except under medical advice, and we shall consider only one of this class, but that one which is most frequently employed, namely, aconite.

Aconite.—The leaves, flowering tops and root of the *Aconitum Napellus*, or monkshood (see Plate XIII.), are employed in medicine, the two first to yield an extract, the last to yield a tincture, the preparation commonly employed.

Tincture of Aconite ....Dose, 5 to 15 drops.
Liniment of Aconite.

The active principle of aconite, aconitia, a most active poison, is employed for the preparation of an ointment.

Actions and Uses.—If aconite be applied to the skin it causes a tingling sensation, followed by numbness. If it be taken into the mouth and swallowed, a similar feeling is experienced in the tongue and gullet, and a sensation of warmth in the stomach, in large doses pain and sickness also. In large doses, after the drug has entered the blood and been distributed throughout the body, the same tingling is experienced in all parts of the body, the most sensitive parts being affected first, tongue and lips, then finger tips, face, breast, and the back last of all. This effect is due to the fact that the drug acts on the ends of the nerves of sensation, and reduces their sensibility. It is, therefore, used as a liniment or as an ointment for painful parts (Note: *where the skin is not broken*), such as in neuralgia, rheumatism, &c. The liniment may readily be used for such a purpose, never the ointment, unless ordered by a medical man, and it must be remembered that some of the drug may gain access to the circulation by the skin and produce its effects upon the body in general. When taken internally, besides the effects already spoken of, aconite specially acts upon the heart and upon the breathing. The heart is very quickly influenced, and usually by counting the pulse this can be noticed in a comparatively few minutes by the diminished pulse-rate. In excessive doses the heart becomes weak and irregular. The breathing is also slowed, made feeble and shallow, and in poisonous doses breathing is usually stopped before the heart ceases to beat. In excessive doses, also, great muscular prostration is experienced along with the tingling and numbness already mentioned, but the mental faculties are unaffected. In doses appropriate for remedial purposes the action is, then, to reduce the force and frequency of the pulse, to diminish the rate of breathing, and to lessen the sensibility of the skin, and also the skin becomes flushed and moist. It is, therefore, in acute inflammatory diseases, and in high fever, that its action would be beneficial. As a matter of fact it is mainly employed in such limited inflammations as quinsy, that is, inflammation of the tonsils and the throat, inflammation of the lungs (pneumonia) in strong and otherwise healthy persons, and in pleurisy. In such diseases its effect upon the heart very considerably abates the inflammatory symptoms, and in scarlet fever and other fevers, where the high degree of heat threatens mischief, it is also employed. In inflammation of the tonsils, inflammatory sore throat, where the pain and swelling of the throat are great, the fever high, the pulse very quick and bounding, and the face flushed, it commonly produces marked relief. As this disorder is not uncommon, and as the drug can be employed for it in a particular manner, which renders its use free from risk, it may be well to state how it should be employed, for the benefit of any who may be far from medical advice. The person should first make a note of the sufferer's pulse, noting number of beats per minute (see p. 11), regularity, &c. A single drop (*1 drop*) of tincture of aconite is then given in a little water, and this dose is repeated every quarter or half hour, according to the urgency of the case, the rate of pulse being noted before each dose, until a considerable slowing of the pulse is perceived,



STRONG SCENTED or POISONOUS LETTUCE
(Lactuca Virosa)

FLY BLOWN MUSHROOM FLY AMANITA
(Agaricus Muscarius or Amanita Muscaria)

DEADLY NIGHTSHADE or DWALE (DEADLY DWALE)
BLACK-CHERRY NIGHTSHADE
(Atropa Belladonna)

after which a drop every hour or every two hours may be sufficient to maintain the effect. Thus, suppose the pulse beating at first 120 times a minute or more, suppose a drop given every quarter of an hour, and in, let us say, three hours, the pulse-rate reduced to 100. Then the drug would be given at intervals of an hour, and if, in another hour, the pulse was still falling, say had fallen to 90, the dose would be stopped. If, after an hour or two, the pulse began to increase in frequency again, the drop every hour would be resumed, and if that did not control it, the drop every half-hour, to be again stopped when necessary.

From its effect on the sensory nerves, aconite is sometimes given internally in painful diseases like rheumatism, gout, lumbago, but is not to be recommended; and there are other drugs more certain to relieve, such as salicine, antipyrin, quinine, &c., which do not require so much caution in their use.

DRUGS WHICH ACT ON THE BLOOD-VESSELS.

The two actions which, for popular purposes, are all that it is desirable to consider under this head, are that by which blood-vessels may be caused to contract, so that less blood flows through them, and that by which they may be caused to dilate, so that more blood may flow through them. The former action one desires to secure locally, when a part of the body is in a state of active inflammation, and would be most readily secured by local cold, the application of cold-water cloths, of iced cloths, of evaporating lotions, and so on. It is the result one seeks also in order to control bleeding, and when the bleeding is external, cold, &c., is applied for that purpose (see under Accidents and Emergencies). On the other hand blood-vessels may be caused to dilate by the use of heat, hot poultices and fomentations, by the external use of mustard, which brings the blood to the skin by paralysing the walls of the vessels of the skin for a time, and so enabling the pressure of blood within them to widen them to their utmost limits. This action is performed when one desires to bring the blood to the skin and so to relieve deeper organs. Thus a mustard poultice over the chest brings the blood to the skin, and tends to relieve any deep-seated inflammation, and a mustard foot-bath is a very efficient way of bringing blood down from the head. There are several drugs, which taken into the system, act upon the blood-vessels in this way, causing their contraction and a diminished flow of blood through them, or causing their relaxation and a more easy flow.

Drugs which Contract the Blood-vessels.

Ergot of Rye is one of the vascular astringents, drugs which contract the blood-vessels. It is obtained from a fungus growing upon the common rye (see p. 565).

Its preparations are:—

	DOSE.
Liquid Extract of Ergot	15 to 30 drops.
Infusion of Ergot	1 ,, 2 fluid ounces.
Tincture of Ergot	15 ,, 60 drops.

Action and Use.—One of the chief actions of this drug is to cause contraction of the smaller arteries, and it is therefore in very common use to control internal bleeding, as from the lungs, womb, bladder, bowels, &c. It has also a special action upon the pregnant womb, which makes it a most valuable drug in bleeding after childbirth and other conditions. **Ergotism** is the term applied to a set of symptoms arising from poisonous doses, or protracted use, and has been seen frequently in certain parts of Germany where rye is the common article of food, and the diseased plant has been made use of. The symptoms are gangrene of the extremities, and nervous symptoms, such as a sensation as of insects crawling over the limbs, loss of sensation in hands and feet, flying pains, and convulsions.

Ergotin is a purified extract of ergot, given in pill form, the dose being 2 to 5 grains.

Ergotinin, the active principle of ergot, is employed to inject, under the skin, when one wishes to secure rapid action of the drug. The dose is $\frac{1}{300}$th grain.

Witch-hazel (*Hamamelis virginica*) or **Winter-bloom** is a shrub, 6 to 8 feet high, growing in damp woods and thickets in Canada and the United States of America. The flowers are collected in autumn. A liquid extract is prepared. In America a preparation known as **Pond's Extract** is derived from witch-hazel. It is clear, like water, and with a peculiar fragrance. A similar preparation is known in Britain as **Hazeline.** Of the two latter a tea-spoonful dose may be taken internally at intervals of 2 or 3 hours, and of a tincture, also prepared, the dose is 2 to 5 drops.

Uses.—Witch-hazel is used both internally and externally for bleeding. In bleeding from lungs, stomach, bowels, kidneys, and bladder any of the preparations named may be taken in the doses noted. For external bleeding, for cuts, and bruises it is applied as a lotion. For bleeding piles it may be used as a lotion, or a tea-spoonful of the tincture in 3 ounces of cold water may be used as an injection. A dry extract is also prepared, which may be used as an ointment or made into a suppository. A tea-spoonful of the tincture, of Pond's extract, or of hazeline, mixed with a table-spoonful of warm water, is a useful lotion for inflamed eyelids, and to discharging sores it is also a valuable application.

Lead is largely employed to contract blood-vessels and control bleeding.

Its chief preparations are:

Acetate of Lead (Sugar of Lead)	Dose 1 to 4 grains in pill.
Lead and Opium Pill	,, 3 to 5 grains.
Solution of Sub-acetate of Lead (Goulard Extract) Dilute Solution of Sub-acetate of Lead (Goulard Water)	used for external application.

Uses.—Lead is extensively employed as a wash for ulcers, sores, and inflamed surfaces, itching diseases of the skin, irritable piles, &c., relieving pain and itching and promoting healing. The highly inflamed and irritable sores are those suitable for this treatment, and the Goulard water is the preparation employed, diluted with several parts of water. The acetate of lead is a common ingredient in eye-washes, but ought not to be used without advice, as in some kinds of eye inflammation it is deposited as a white crust on the front of the eyeball. When given internally lead has a strong astringent action on the lining membrane of the stomach and bowels, and is used for bleeding from these surfaces and for diarrhœa and dysentery. The lead and opium pill is thus given, but ought not to be used without advice. Absorbed into the blood, it passes into distant organs and controls bleeding from the lungs, kidneys, and womb.

Lead-poisoning is frequent among painters, those engaged in colour-grinding, plumbing, type-founding, &c. The lead is derived from particles adhering to the hands and swallowed with food, from dust getting into the mouth, and inhaled from the clothes, &c. All workers among lead ought, therefore, to wash their hands and use a tooth-brush to the teeth before taking food, should not take food in the room where the work is going on, and ought to change their clothing as soon as work is over. A flannel respirator over the mouth and nose is, in some cases, needed, to prevent inhalation of the dust. Chronic lead-poisoning also arises from drinking waters contaminated with the metal. The symptoms of lead-poisoning are a blue line along the gums, colic in the bowel, usually accompanied by loss of appetite, cramps in the calves of the legs, and paralysis of certain muscles. Those of the wrist are chiefly affected, producing the characteristic "wrist drop," due to an inability to raise the wrist on the forearm. Headache and other brain symptoms also occur, disease of the kidneys also, and disease of the nerve of the eye, leading to dimness of vision and perhaps blindness. The treatment of lead-poisoning consists in removing the person from the source of the lead, and in giving some medicine which will aid in removing the lead from the body. For this purpose iodide of potassium is the drug used, in 5-grain doses, dissolved in water, given several times a day. Workers among lead are advised to take an occasional dose of Epsom-salts acidulated with a few drops of sulphuric acid as a preventative.

Drugs which Relax the Blood-vessels.

We all know that there are many means of relaxing the smaller blood-vessels of a part of the body and thus bringing a more copious supply of blood to the part. Thus putting the feet or hands in hot water brings the blood rapidly to the skin of these parts, and this can be effected elsewhere by the use of hot-water pads, hot poultices, and the like. Irritating substances, like mustard, have a similar effect. A mustard poultice reddens the skin by dilating the blood-vessels, and mustard, cayenne, camphor taken by the mouth, have a similar effect on the walls of the digestive canal. Such methods are often employed to withdraw blood from one part of the body threatened with or suffering from inflammation. Thus the purpose of applying a mustard poultice or a fly-blister to the walls of the chest in bronchitis or inflammation of the lung is to draw the blood from the deeper parts to the skin and so relieve the inflammation. The usual object of taking substances by the mouth which shall redden the walls of the stomach and bowels is to stimulate them to greater activity in the work of digestion, by bringing a more copious supply of blood for the production of the digestive fluids. Then there are many remedies which act upon special organs, exciting their blood supply and increasing their activity. For example, solution of acetate of ammonia relaxes the blood-vessels of the skin, and increases sweating. Alcohol has a pronounced effect of this kind. It dilates the surface blood-vessels all over the body, and thus induces a feeling of warmth. As a matter of fact, however, instead of causing an actual increase of heat to the body, it occasions a positive loss of heat, from the increased loss from the surface (see p. 673). There are one or two drugs which very quickly dilate the blood-vessels all over the body; the chief of these is nitrite of amyl.

Nitrite of Amyl. This is prepared from amylic alcohol and nitric acid. It is an ethereal liquid of a yellowish colour, a pungent aromatic taste, and peculiar fruit-like odour. It was introduced as an anæsthetic by Dr. Richardson in 1863. When 2 or 3 drops are placed on a handkerchief and inhaled, after a momentary tickling sensation at the throat causing cough, the face begins to flush, the pulse becomes faster and fuller, and the breathing is much quickened. In about a minute the vessels of the head are felt to throb, there is a feeling of fulness in the head and a sensation of giddiness, especially if the person sits up. If a larger quantity be inhaled, the breathing becomes laboured, and the face becomes crimson, and later of a darker hue, and the sight becomes dimmed. These effects are due to the dilatation of the smaller arteries permitting a fuller and freer flow of blood to the surface, to quickening of the heart, and to an interference with the exchanges between the blood and the air. The drug is employed to dilate the smaller arteries in order to relieve spasm in angina pectoris (p. 243). The peculiar and intense pain of this disease seems to be due to some spasmodic condition of the smaller arteries, by which they become contracted in calibre, the pressure of blood within them consequently rising. It was because experiment had shown that nitrite of amyl had the power of producing an exactly contrary effect, dilating the small arteries and lowering the blood pressure, that it came to be tried in this disease. Results obtained from it have been just those which were anticipated, and it has become one of the chief drugs relied on to relieve the spasm. In some cases it has failed, and it has been suggested, that the failure may have been due to perfectly fresh nitrite not having been employed. It may be, that is to say, that the drug loses its power with keeping.

Pure asthma, nervous asthma, is also a spasmodic condition, in which the smaller bronchial tubes are greatly contracted. For this condition also nitrite of amyl is employed, and often with relief. It is for these purposes inhaled from a handkerchief in doses of from 2 to 5 drops, and the person should be lying down, lest faintness occur, and be attended by some one. It should not be given to full-blooded people, in whom there is any risk of apoplexy. It has been tried for epilepsy, sick headache (migraine), sea-sickness, but without much success.

Nitro-glycerine is employed in medicine in doses of from $\frac{1}{200}$ to $\frac{1}{50}$ grain, to produce effects similar to those due to nitrite of amyl.

Spirit of Nitro-glycerine, ... Dose, ½ to 10 drops.
(1 grain of nitro-glycerine in 100 drops of rectified spirit.)
Tablets of Nitro-glycerine, .. ,, 1 or 2 tablets.
(Tablets of chocolate weighing $2\frac{1}{2}$ grains, and containing $\frac{1}{100}$ grain pure nitro-glycerine. Other strengths are also prepared.)

Nitro-glycerine acts like nitrite of amyl, and has been used for angina pectoris, epilepsy, neuralgia, spasmodic asthma, puerperal convulsions, neuralgia of stomach, and many other diseases. Its usefulness in many is dubious; in many persons the smallest dose produces intense headache; and in any case it is a drug of such power that a physician would use it only with great caution. In poisonous doses it produces great depression, the pulse and breathing become very much quickened, paralysis of motion and of sensation is produced; and if death results, it is by arrest of the breathing.

SECTION III.—DRUGS WHICH ACT ON THE STOMACH, BOWELS, LIVER, AND DIGESTIVE SYSTEM GENERALLY.

Drugs which Act on the Stomach.

- **Stimulants to the Stomach—Tonics:**
  - *Bitter Tonics—Angostura Bark, Calumba Root, Cascarilla Bark,*
    - *Chamomile Flowers, Chiretta, Gentian Root, Hops, Peruvian Bark, and Quinine,*
    - *Quassia Chips, Serpentary,*
    - Their Preparations and Doses;
  - *Acid Tonics—Dilute Hydrochloric, Nitric, and Sulphuric Acids;*
  - *The Uses of Acid Tonics;*
  - *Alkaline Tonics—Soda and Potash, Ammonia, Magnesia, and Lime;*
  - *The Uses of Alkaline Tonics.*
- **Artificial Digestive Agents:**
  - *Pepsin*—Its Preparation and Uses;
  - *Pancreatin and Liquor Pancreaticus;*
  - *Papain*—Its Ferment Action, and its Use in Diphtheria;
  - *Ingluvin and Lactopeptin.*
- **Remedies for Flatulence of Stomach:**
  - *Anise, Assafœtida, Camphor, Cayenne, Dill, Ginger, Peppermint,* &c.
- **Emetics:**
  - *Warm Water, Mustard and Water, Infusion of Chamomile Flowers, and Carbonate of Ammonia* as Emetics;
  - *Sulphate and Acetate of Zinc, Copper, and Alum* as Emetics;
  - *Ipecacuanha*—Its Preparations, Doses, and Uses;
  - *Antimony* (Tartar Emetic);
  - *Apomorphia.*
- **Remedies which Soothe the Stomach:**
  - *Ice* as a Sedative to the Stomach;
  - *Bismuth*—Its Preparations and Uses;
  - *Dilute Hydrocyanic Acid;*
  - *Belladonna, Opium, Oxalate of Cerium, Chloroform, Ether, Cocaine,* &c., as Sedatives to the Stomach.

Drugs which Act on the Bowels and Liver.

- **Remedies for Constipation:**
  - *Laxatives—Fruits,* &c.
    - *Castor-oil; Senna* and its Preparations;
    - *Sulphur; Tamarind; Tamar Indien and Tamarind Whey;*
    - *Buckthorn, Dandelion* (Taraxacum), *Glycerine, Olive-oil,* &c.
  - *Simple Purgatives—*
    - *Rhubarb and Aloes;*
  - *Stronger Purgatives—Cathartics—*
    - *Colocynth,* Gregory's Pill;
    - *Scammony and Jalap.*
  - *Drastic Purgatives—*
    - *Elaterium, Croton-oil, and Gamboge.*
  - *Saline Purgatives—*
    - *Epsom-salts, Seidlitz-powders, Fruit-salts;*
    - *Cream of Tartar, Rochelle-salts, Glauber's-salts.*
  - *Purgatives which Increase the Flow of Bile—*
    - *Podophyllin; Euonymin; Iridin;*
    - *Hydrastin; Leptandrin; Juglandin;*
    - *Phytolaccin.*
- **Remarks on the Use of Purgatives.**
- **Remedies for Diarrhœa:**
  - *The Use of Opium, Castor-oil, Magnesia, Chalk, and Soda* in Diarrhœa;
  - *Tannic and Gallic Acids;*
  - *Catechu; Kino; and Rhatany;*
  - *Red Gum; Bael Fruit; Logwood; Oak and Elm Bark;*
  - *Alum, Iron, Copper, Zinc, and Silver Preparations.*
- **Remarks on the Use of Remedies for Diarrhœa.**

Remedies for Flatulence of the Bowel.

Remedies for Intestinal Worms: Anthelmintics:

- *Remedies for Tape-worm—Male-fern and Areca-nut;*
  - *Kamala and Kousso;*
  - *Pomegranate Root Bark and Turpentine.*
- *Remedies for Round-worms—Santonica and Santonin;*
  - *Spigelia Root.*
- *Remedies for Thread-worms—*
  - *Injections of Salt, Quassia, &c.*

Injections for the Bowels: Enemata:

- *Nutritive and Stimulant Enemata;*
- *Opening and Purgative Enemata*—Salt, Soap, Castor-oil, Aloes, Turpentine, &c.;
- *Opium and Astringent Enemata*—Enemata for Pain and Diarrhœa;
- *Enema for Piles.*

Remedies which Act upon the Liver:

- *Stimulants to the Liver—*
  - *Nitro-hydrochloric Acid; Chloride of Ammonium.*
- *Drugs which Depress the Liver—*
  - *Quinine, Opium, &c.*

In this section we must consider the action of remedies upon several organs, stomach, small and large intestine, and liver, all of which are concerned in the digestive process. It is really impossible completely to limit the action of a medicine to one of these organs, and the effect which a medicine produces will most commonly be the combined result of its action upon several parts of the digestive canal. If, therefore, we consider the remedies which act upon the digestive apparatus under several subdivisions, such as those which act on the stomach, those which act on the bowel, those which act on the liver, and so on, it must be understood that the arrangement is mainly for convenience, and that the same remedy may be entitled to be included in each division.

DRUGS WHICH ACT ON THE STOMACH.

That the stomach may be acted upon in a variety of ways in order to influence the manner in which it performs its work in the digestion of the food will be plain to everyone who studies that part of Section IV. A. of Part I. which deals with the structure of the stomach (p. 138) and digestion in the stomach (p. 143). There it has been pointed out that digestion is carried on by the agency of the gastric juice, manufactured by the glands of the stomach from blood flowing in the vessels of the mucous membrane, aided by heat and the movements of the stomach walls. The quantity of gastric juice manufactured depends on the activity of the circulation, and it has been mentioned (p. 139) that the mere contact of the food with the wall of the stomach excites increased blood supply to the glands and increased flow of the digestive fluid. It has also been explained that the chief ingredients of the gastric juice are hydrochloric acid and pepsin, and that the whole process is under the influence of the nervous system. It is clear, then, that drugs may be given (1) which shall slightly irritate the mucous membrane of the stomach and determine a much larger flow of blood and, therefore, increased production of gastric juice; or (2) which shall also excite more marked movements of the muscular walls. But sometimes gastric juice in sufficient quantity may be produced but it is not sufficiently active, because of being deficient in acid or in pepsin, owing, it may be, to a state of general debility. In such a case (3) the deficient quantity of acid or pepsin may be made up by some being taken as a medicine. In all these cases the object is to stimulate the stomach, to rouse it to do its work better, more quickly, or more completely. These drugs will, therefore, be rightly called **stomach stimulants or tonics.** On the other hand, the lining membrane of the stomach may be unduly irritable, when the smallest quantity of food is apt to be rejected, as it often is in catarrhal states. Under these circumstances medicines which will soothe the stomach and diminish the irritability are desired, and these are called **stomach sedatives.** Another class of remedies are useful when, owing to some form of indigestion, the contents of the stomach become too acid, leading to heart-burn and acidity, or when the stomach is distended with wind and pained by the irregular spasm it induces. To the former remedies the term **antacids** is applied, and to the latter **carminatives** (from Latin *carmen*, a song, a charm), because they act quickly in relieving spasm as by a charm. Finally, there is a class of drugs employed to excite the stomach to eject its contents by vomiting—**emetics.** It is under these divisions that we shall consider the drugs which act on the stomach.

Stimulants to the Stomach: Tonics.

Bitter Tonics.

Bitter tonics are among the simplest of the drugs which stimulate digestion in the stomach. This they appear to do by stimulating an increased flow of gastric juice by their chemical action on the stomach walls, reddening the surface, bringing an increased supply of blood, exciting the nerves of the stomach, and thus improving the appetite and increasing the relish for food, as well as actually aiding the digestive process.

The chief bitter tonics are:

Angostura or Cusparia.
Calumba.
Cascarilla.
Chamomile.
Chiretta.
Gentian.
Hops.
Peruvian Bark and Quinine.
Quassia.
Serpentary.

The common form in which these substances are employed is that of infusion, and the usual dose is from 1 to 2 ounces.

It must not be forgotten that the action of these substances is stimulating, or to put it in other words, mildly irritating. If too much of the drug be used, or in too strong a form, the irritation may become excessive, and produce effects exactly the opposite of those desired, loss of appetite, diminished digestive power, and even sickness and vomiting. A very good example of this is afforded by the infusion of chamomile flowers, of which a dose of from 1 to 2 or even 3 ounces is a stomach stimulant, while 5 to 10 ounces act as an emetic. And here we have an illustration of the complex problem one often meets with in the treatment of disease—the indigestion of which one person complains may arise from an undue irritability of the mucous membrane of the stomach. If he seeks relief by the use of a bitter tonic, he will probably be surprised to find that, instead of aiding his digestion and improving his appetite, as he has been informed is its usual effect, the bitter has increased his disagreeable sensations. In short, the stomach already too irritable, is made still more so by the stimulating action of the medicine, and what he requires is a soothing remedy. One guide to the nature of the stomach condition is the appearance of the tongue, a very red tongue with prominent papillæ on its surface indicating an irritable stomach, while a flabby whitish tongue indicates the reverse.

Angostura or **Cusparia Bark** is the dried bark of a tree of tropical South America, the *Galipea Cusparia.* To make the infusion take 1 ounce of the bark in coarse powder, and add 20 ounces distilled water, heated to 120°; infuse two hours and then strain. It is used as a tonic in cases of weak digestion, and in recovery from acute diseases; and in warm climates it is found useful in intermittent fevers and dysentery. It may be noted that false angostura bark is the bark of the *Strychnos nux vomica,* which is poisonous, and the substitution of which for the pure bark has led to fatal accidents. The two may be distinguished from one another by the fact that the false bark when touched with nitric acid on the inner surface becomes blood-red, from the presence of a substance called brucia; the true bark does not.

Dose of infusion—1 to 2 ounces.

Calumba Root. The root of the *Jateorhiza Calumba,* or *Cocculus palmatus,* indigenous to the forests of Mozambique, and abundant along the lower Zambesi River. The infusion is made with 1 ounce coarsely-powdered root steeped for one hour in 20 ounces *cold* distilled water, and then strained. A tincture is also made which keeps, while the infusion does not.

Dose of infusion 1 to 2 ounces (2 to 4 table-spoonfuls).
,, tincture ½ to 2 tea-spoonfuls.

Cascarilla Bark, or sweet-wood bark, the bark of *Croton Eleuteria,* comes from the Bahamas. Of it also an infusion and a tincture are prepared, the former by pouring 10 ounces boiling distilled water over 1 ounce of the coarsely-powdered bark, and straining after an hour's infusion. The infusion does not keep well.

Dose of infusion 1 to 2 ounces, of tincture ½ to 1 tea-spoonful.

It is used not only as a tonic to the stomach, but also as an aid to the expulsion of phlegm from the air-passages in chronic bronchitis.

Chamomile Flowers are the dried flower-heads of the common chamomile, *Anthemis nobilis,* cultivated for the purpose. The infusion is made with ½ ounce of the flowers and 10 ounces of boiling water. It is strained after a quarter of an hour's infusion.

It is used as a tonic for indigestion with flatulence, and also for summer diarrhœa of children, and for sick headache; and is a useful lotion, when diluted with 1 or 2 table-spoonfuls of warm water, for inflamed eyelids. An oil may be distilled from the flowers.

Dose: 1 to 3 ounces as a tonic, 5 to 10 ounces as an emetic.

Chiretta is the entire plant of the *Ophelia Chirata*, collected in Northern India. The infusion is yielded by 1 ounce of the dried plant, cut small, and 40 ounces water heated to 120°, and is strained after half an hour. It is a pure bitter tonic, and has properties similar to gentian; its dose being the same.

Gentian Root is the dried root of the *Gentiana lutea*, found in mountainous districts of Central and Southern Europe, the Alps, Apennines, &c. From it are obtained a compound infusion and a compound tincture. The former is made with 1 ounce of the root, 1 ounce of bitter orange peel, 2 ounces of fresh lemon peel, and 80 ounces boiling water, infused one hour, and then strained. It is a very generally used tonic, a pure bitter, and also useful as a general tonic. An extract is employed in pill.

Dose: of infusion 1 to 2 ounces, of tincture ½ to 1 tea-spoonful.

Hops. The dried flower-spike of the female plant of the *Humulus Lupulus*, cultivated largely in England, is used to yield an infusion and a tincture, and also an extract. Of hops 1 ounce is used to 20 ounces of boiling water, and allowed to infuse for two hours; it is then strained. Hops contain a bitter principle—lupuline—and a volatile oil. They are used to impart the bitterness to beer. Besides being useful as a tonic to the stomach, hops have a soothing effect on the nervous system, tending to produce sleep. They are sometimes used in the form of a poultice or fomentation for painful swellings.

Dose: of infusion 1 to 2 ounces, of tincture ½ to 2 tea-spoonfuls.

Quassia Wood is the wood of *Picræna excelsa*, growing in Jamaica. It is obtained in the form of chips and raspings. An infusion (60 grains of the chips infused for half an hour in 10 ounces distilled water and strained) and a tincture are its chief preparations. It contains a bitter principle, quassiin, but no tannin, and is therefore a simple bitter without astringence. Too large a dose is irritating to the stomach and causes vomiting. This wood is often made into a cup which imparts its bitterness to water allowed to remain in it for a short time. An infusion is used as an injection into the bowel to destroy thread-worms. The dose is the same as of gentian.

Serpentary—the underground stem of the *Aristolochia Serpentaria*, belonging to the southern part of North America. From it an infusion and tincture are prepared. The former is made with 1 ounce of bruised serpentary infused for two hours in 40 ounces of boiling water and strained. It is used in the production of compound tincture of cinchona (p. 820). It not only acts as a tonic to the stomach, but also stimulates the action of the kidney and skin, and is therefore employed in chronic rheumatism, and in low fevers.

Dose: of infusion 1 to 2 ounces, of tincture ½ to 1 tea-spoonful.

Peruvian Bark and Quinine have already been considered on p. 820.

Acid Tonics.

The acids chiefly used as stimulants to the stomach are:—

Dilute Hydrochloric Acid	Dose	10	to	30	drops.
Dilute Nitric Acid	,,	10	,,	30	,,
Dilute Nitro-hydrochloric Acid	,,	5	,,	20	,,
Dilute Sulphuric Acid	,,	5	,,	30	,,
Dilute Phosphoric Acid	,,	20	,,	30	,,

The Uses of Acids. There is an obvious purpose in using acid to assist digestion. We have seen (p. 143) that the gastric juice is acid, that digestion in the stomach cannot occur unless the fluid be acid, and that the acid present is hydrochloric. It is easy to argue, therefore, that in cases of indigestion, the administration specially of hydrochloric acid will be a great aid, and in many cases this is so. For example, a person who, immediately after food, suffers from a feeling of weight in the stomach, which persists for a long time, and has hardly passed away before the next meal is due, or who after food is afflicted with a feeling of sickness, accompanied by the rising into the mouth of a quantity of a tasteless watery fluid (water-brash, see p. 181), perhaps ending in the vomiting up of a quantity of the unaltered food, will probably find much relief from taking 10 drops or so of hydrochloric acid in half a wine-glassful of water *after meals*. But this fact of the acidity of the natural stomach juice is not the only one which determines the employment of acids in stomach derangements. It is found that glands which produce an acid juice are excited to their work, or stimulated, by substances of an opposite character, that is by alkalies such as soda, potash, &c., and that their activity is diminished by the application of acid substances. On the other hand glands which produce an alkaline fluid are stimulated by acids, but have their activity lessened by soda or potash and such substances. Thus the fluid poured into the mouth from the salivary glands is alkaline, and we know what a rush of fluid comes to the mouth when an acid substance is tasted, which is not experienced when some soda in water is taken. Thus a few drops of acid in water will promote the flow of the saliva into the mouth, but when it reaches the stomach will diminish the flow of the acid gastric juice. If acids are taken to assist digestion it must not be before food, for then they would only diminish the flow of gastric juice, but it ought to be after food, when the gastric juice has already been mixed with the food and one wishes to increase its acid properties. On the other hand if acidity and heartburn come on very soon after a meal, this implies that too much acid gastric juice is poured into the stomach. In such a case by taking acid *before a meal*, a person would hope to *lessen* the quantity of juice secreted, and so remedy the acid indigestion. But any one who is troubled with acidity and takes some drops of acid after food can expect only to increase his affliction. Exactly the reverse holds true with reference to alkalies, that is soda and potash. Soda or potash taken *immediately before a meal* excites by its antagonism a flow of the acid stomach juice, and is therefore a powerful remedy for indigestion due to deficiency of that digestive fluid. They should be taken *after a meal* only to correct acidity and heartburn, when they no longer encourage the flow of gastric juice, but neutralize some of the excess of acid. As a general rule, then, we may lay it down that to stimulate the stomach to the digestive process acid tonics should be taken *after meals*, and that a like purpose is served by taking alkaline (soda, potash) remedies *immediately before meals*. The best acid to use for this purpose is dilute hydrochloric acid. A similar explanation is offered for the value of acid drinks in relieving thirst, and moistening the mouth in fevers. They so stimulate the salivary glands and the glands of the mouth that a copious watery secretion results which moistens the mouth and throat. For this purpose a preparation of sulphuric acid, aromatic sulphuric acid, is very useful, a few drops in a glass of water. Citric acid, prepared from the juice of the lemon or lime, is also valuable, 17 grains in an ounce of water making a solution resembling lemon juice.

Besides the effects in the stomach that have been noted, acids produce a further action when they reach the small intestine, explained in a similar way. The bile is poured into the small bowel a few inches below the opening of the stomach, and the pancreatic juice in its neighbourhood. Both these juices are alkaline, and thus when the acid contents of the stomach pass over the openings of the channels from these organs, the result of the irritation is a copious flow of the two juices. Acids are thus frequently given for the avowed purpose of stimulating the liver, the dilute hydrochloric and dilute nitro-hydrochloric acids, in 10-drop doses, being specially used for this purpose. In chronic cases of sluggish liver they are very serviceable. They are also used as general tonics, phosphoric acid being employed in cases of nervous exhaustion.

It must not be forgotten that while the use of dilute acid in indigestion may afford great relief in appropriate cases, it must not be too long continued. Their employment for a prolonged period continuously defeats the end aimed at. Their beneficial effects become lessened because, by and by, they tend to induce catarrh of the stomach and bowels. The proper plan, therefore, is to employ them for a week or two, then to stop and substitute an alkaline tonic, taken before food (see below), for a week or two, and then, if need be, to return to them again for another brief period. This tendency with prolonged use to set up catarrh, and therefore interfere with digestion, is alleged as the reason for the effect of vinegar in reducing fatness, and this is not a purpose for which they ought to be used. The scientific method of reducing fat is fully explained on p. 625.

For many other conditions of the stomach and bowels, besides that of simple indigestion, are acids administered. Their constringing action on the lining membrane makes them useful in bleeding from the stomach or bowels and in diarrhœa, dilute sulphuric acid being the one specially used. Indeed sulphuric acid is employed for controlling bleeding in other organs, the lungs and womb, for example. To reach these organs it must pass into the blood, and it is not conveyed in the form of acid but in chemical combination as sulphates, and how it in this condition controls bleeding is unknown. It has also a marked effect in relieving profuse sweating. The organic acids, citric, tartaric, and acetic, chiefly the former, are employed in rheumatism, but they never reach the tissues in that shape, but in the form of citrates of potash, &c. &c., when they have lost their acid properties.

It will complete our view of the action of acids, and avoid the necessity of anything more than a mere reference in other sections, if we note here some of the local actions of acids. In their undiluted form they are powerful irritants, and some of them exert powerfully destructive actions on the tissues. They are occasionally used for such purposes. Strong nitric acid is employed to destroy foul sores, and to restore a healthy action to certain ulcers. Applied immediately to a part bitten by some poisonous animal, it prevents the possibility of absorption of the poison into the system. Acetic acid and glacial acetic acid are applied to warts. Such applications must be made with the greatest care, the part being simply lightly touched with a glass rod dipped in the acid and immediately thereafter bathed with cold water, and special care must be taken to prevent the acid running on to the sound skin. Dilute acid is used with which to sponge the skin in fever, producing a grateful cooling effect, and is similarly used to limit excessive sweating. Very dilute solutions of acetic and sulphuric acids are the best for this purpose. A tea-spoonful of *dilute* nitric acid to a pint of water used as a lotion for swollen and bleeding piles affords marked relief.

Alkaline Tonics and Remedies for Acidity: Antacids (Soda, Potash, &c.).

The alkaline medicines used as tonics are:—

Compounds of soda,
,, ,, potash,
,, ,, ammonia,
,, ,, magnesia,
,, ,, lime.

Potash and soda have already been discussed on p. 818 and 819, the chief compounds employed being the bicarbonates of potash and soda and the solution of potash. We shall note a few of the preparations of ammonia, magnesia, and lime, and then consider the effects of alkaline tonics as a group, as we have done with acids.

Ammonia is, when pure, a colourless gas with a very pungent odour. The ordinary liquor ammonia, or hartshorn, is a solution of the gas in water. It was called hartshorn because it was readily obtained from animal substances, such as horn, hoof, &c. The chief compounds of ammonia are as follows:—

Strong Solution of Ammonia,
Ammonia Water (Hartshorn) ...Dose, 10 to 20 drops well diluted.
1 ounce of the strong solution mixed with 2 ounces of water.
Aromatic Spirits of Ammonia. Dose, ½ to 1 tea-spoonful in water.
Carbonate of Ammonia.......... ,, 3 to 10 grains.
Chloride of Ammonium.......... ,, 5 ,, 20 grains.
Solution of Acetate of Ammonia (see under Section on Drugs that act on the Skin).
Bromide of Ammonium (see under Section on Drugs that act on the Nervous System).

Uses.—Ammonia is used externally as a stimulant. Thus the vapour of hartshorn and of carbonate of ammonia in the form of smelling-salts is employed in fainting and to relieve headache, when sniffed up the nose. It must not be used too strong, as it might excite inflammation. Applied to the skin as hartshorn it reddens the part, and is, therefore, used for rheumatic joints and as a liniment for other affections. Similarly when ammonia is taken into the stomach, either as hartshorn diluted, or as carbonate of ammonia, or as the aromatic spirit, it stimulates, producing a feeling of warmth in the stomach; and it excites the stomach and bowels to the expulsion of wind. For such a purpose the aromatic spirits are best.

The chloride of ammonium has a special action on the liver, and is largely used in tropical countries for congestion and other chronic liver diseases. Entering the blood it acts as a general stimulant, rousing the heart and nervous system, and rallying the vital powers in states of exhaustion, exciting also the air-passages and the nerves connected with the lungs and aiding in the expulsion of mucus from the air-tubes in chronic bronchitis. For these latter purposes 5-grain doses of the carbonate are best. If 30 grains of this drug be given well diluted it acts as an emetic, and is occasionally used for this purpose in chronic bronchitis and croup, as the vomiting expels also the material from the air-passages. Ammonia is used in cases of snake bite, and for relief of stings of insects. For the latter weak solutions of hartshorn are applied to the part, and act by destroying the poison of the bite; for the former 10 drops of the strong liquor diluted with 30 of water are injected into the veins, and act by their stimulating property on the circulation and nervous system.

What is said a little further on as to the uses of alkaline medicines in indigestion is applicable to ammonia, the preparation chiefly used being the aromatic spirits. It is not commonly employed alone but along with soda or potash and with some bitter infusion.

Magnesia.—The chief preparations of magnesia are:—

	Dose.
Carbonate of Magnesia...........	10 to 60 grains.
Fluid Magnesia (Solution of Carbonate of Magnesia)...	1 to 2 fluid ounces (2 to 4 table-spoonfuls).
Light Magnesia......................	10 to 60 grains.
Heavy Magnesia (Ponderous Magnesia).....................	10 ,, 60 ,,
Sulphate of Magnesia (Epsom Salt)...........................	60 grains to ½ ounce.

Uses.—Magnesia is chiefly given for correction of acidity of the stomach and heartburn and for acidity of the bowels. The carbonate, light and heavy magnesia are not easily dissolved, and they are therefore specially useful for acidity. They also act upon the bowels so as to cause a copious flow of watery secretion, producing loose motions. As they have not much stimulating effect they cause no griping pains and are thus useful for children, for whom they are often combined with rhubarb, as in Gregory's powder. A useful combination would be 5 drops or more of the aromatic spirits of ammonia. The action of Epsom salt will be discussed under Purgatives, in this section.

Magnesia in powder is, however, given too freely, and is apt to form little stony concretions in the bowel if persistently used in any quantity. Magnesia is a common antidote for poisoning with strong acids, oxalic acid, mercury, arsenic, and copper, as it forms with them insoluble salts.

Lime or chalk.—Its chief preparations are:—

	Dose.
Prepared Chalk (Carbonate of Lime)...	10 to 60 grains.
Lime-water (shake up slaked lime in water. Allow to stand, and pour off the clear fluid)............	½ to 4 ounces (1 to 8 tablespoonfuls).
Saccharated Solution of Lime..........	15 to 60 drops.
Chalk Mixture..................................	1 to 2 ounces.
Aromatic Chalk Powder.....................	10 to 60 grains.
Grey Powder (Mercury with Chalk)...	2 to 8 grains.
Phosphate of Lime............................	10 to 20 grains.
Hypophosphite of Lime.......................	5 to 10 grains.

Uses.—Lime is, like magnesia, exceedingly useful as a corrective of acidity and heartburn when given after food. It has also an astringent property, for which it is much used in looseness of bowels, specially in the form of chalk mixture, or for children the aromatic powder. Lime-water is given freely to children being artificially reared, much too freely in the author's opinion. Over and over again he has asked mothers and nurses for what purpose the lime-water was added to the milk; and if he has received any answer, for commonly no reason except that of custom or the advice of somebody supposed to know has been forthcoming, the answer has been that it was to help in the formation of the child's bones. This idea is quite incorrect, most of the lime is expelled in the motions. The actual reason for the addition of the lime-water is that it destroys—neutralizes—some of the acid of the gastric juice, and therefore prevents the rapid action of the juice on the milk, in short slows the process of digestion in the stomach. It must be remembered that the first effect of the gastric juice is so to act upon the milk as to separate it into a curd and whey, and then the curd is further attacked and broken down. Now mother's milk forms, in the stomach of the child, a very fine curd, in small flaky pieces which are easily digested. Cow's milk, however, forms much larger and more solid masses, which are apt to irritate the child's stomach and cause vomiting, griping pains, colic, diarrhœa, &c. The addition of the lime-water, by diminishing the acidity of the gastric juice, slows the process, so that smaller pieces are formed. It is, therefore, quite a correct thing to do *if it is necessary*, if, that is, the child shows any difficulty in digesting the cow's milk when prepared in a proper way (see p. 441), and if simple boiling, which prevents the milk curdling in large masses, does not prove sufficient to remove the difficulty. But the use of lime-water *as a matter of course* and without any proof of its necessity in the milk prepared for every hand-fed infant, and in every bottle, is a thing to be most strongly objected to and prevented. When it is necessary about one tea-spoonful of lime-water, or 15 drops of the saccharated solution, may be added to the milk. For diarrhœa a similar quantity and upwards may be used. The phosphate and hypophosphite of lime are the preparations employed in growing children suffering from chronic diarrhœa and general weakness, but they are more advantageously given in combination with tonics, as in Parrish's Chemical Food, Syrup of the Hypophosphites, &c. (see p. 817).

Chalk is employed as a dusting powder for burns, ulcers, and weeping patches of skin eruptions, for its soothing and astringent effect. Lime-water is used for the same purpose; and Carron-oil, a mixture of lime-water and linseed-oil, is one of the most soothing of applications to burns. Lime-water is also employed as a mouth-wash in ulceration, and for injection into the bowel to destroy round-worms.

The Uses of Alkalies.—The conditions under which acid tonics are found to be useful in indigestion have been stated in detail on p. 842, and enable one to understand also under which circumstances medicines of an opposite chemical character should be employed. The stomach juice is acid, and its flow will, therefore, be stimulated by a remedy of an opposite kind, soda or potash. The appropriate time, therefore, for the administration of alkaline tonics is immediately before food, so that the food afterwards introduced into the stomach is met by an abundant secretion of juice for its digestion. In all cases of slow digestion, in which the food lies like a weight for hours after it has been taken, and after an hour or two, it may be, causes great uneasiness by the development of flatulence owing to improper fermentations arising, in all such cases alkaline remedies before food should first be tried, in preference to acid remedies taken after food. They are not usually taken alone, but in combination with some other substances, which will aid their stimulating action on the stomach. For example, a few grains—3 to 5—of bicarbonate of soda or potash, along with half a tea-spoonful of aromatic spirits of ammonia, and a tea-spoonful of a bitter tonic, say infusion of calumba, or other bitter infusion (see p. 840), or ½ tea-spoonful of compound tincture of gentian, in a wine-glassful of water, would make such a combination as would be found suitable for many cases of weak and sluggish digestion, or **atonic dyspepsia**, as it is called. If such treatment did not yield complete relief, then, after a time, one would substitute an acid tonic, taken *after food*, say 5 to 10 drops of dilute hydrochloric acid, along with a bitter infusion also.

An entirely opposite effect to that which has been described is obtained by giving soda or potash *after* a meal. Then the alkali simply mixes with the acid contents of the stomach and neutralizes some of the acid, so that the total acidity is diminished; it has then no effect upon the secretion of gastric juice. It is in cases of acidity and heartburn that the soda and potash are useful in this way. Here also it is well to give them in combination with such a preparation as the aromatic spirits of ammonia, which will aid in the expulsion of any wind that has formed. It is to be noted, however, that this use of alkalies is able to give only temporary relief. It diminishes the acidity at the time, but does not remove the condition which has been the cause of the disturbance. Acids given *before food* will, on the principle already explained, *restrain* the secretion of the acid gastric juice, and may thus prevent the excessive acidity from occurring at all. We may then usefully summarize the results of the employment of acids and alkalies in indigestion by the following table:—

Acids given after food increase the acidity of the gastric juice,	and thus promote digestion.
Alkalies given before food stimulate the secretion of the gastric juice, ...	
Acids given before food restrain the secretion of the gastric juice, ...	and thus relieve acidity and heartburn.
Alkalies given after food diminish the acidity of the gastric juice,	

In certain forms of diarrhœa, dependent upon the irritation produced in the bowel by the excessive acidity of the bowel contents, soda, potash, magnesia, and lime, by neutralizing some of the acid, are most valuable. The benefit derived from such drugs in increasing the alkaline character of the blood has already been pointed out on p. 818.

The principle that an alkaline solution will increase an acid secretion, but will restrain an alkaline one, explains the effect of a solution of carbonate of soda in certain skin diseases, accompanied by raw surfaces, which weep copiously, such as eczema. The fluid from the eczema is alkaline, and is much relieved by bathing with 30 grains of the carbonate to a pint of water. The itching of nettle-rash and other skin affections is often wonderfully relieved by a similar lotion, or one double the strength.

Artificial Digestive Agents.

The ferment—pepsin—present in the gastric juice can be separated from the stomach of animals, such as the pig and the calf, and can be prepared in a pure state, and administered as a medicine to those whose indigestion seems to depend upon deficient quantity or quality of the gastric juice. In the same way the ferment of the pancreatic juice—pancreatin—can be prepared and employed as a medicine. Recently it has been found that the juice of the papaw-tree has digestive properties resembling those of pepsin, and from it a ferment—papain—has been separated, of which we shall give also a brief note.

Pepsin.—The ordinary pepsin is prepared in the following way:—The stomach of a recently killed pig, sheep, or calf is opened up and laid on a board, inner surface upwards. Adhering portions of food, dirt, &c., are washed off by a gentle stream of cold water. The surface is then scraped with a blunt knife or other suitable instrument, and the scrapings spread on a surface of glass or glazed earthenware, and quickly dried at a temperature not exceeding 100° Fahr. The powder thus obtained is yellowish-brown, with a peculiar odour, and should be kept in a dry stoppered bottle. A glycerine extract of pepsin is easily made by stripping the inner lining membrane—the mucous membrane—off the stomach of a recently killed pig or calf, cutting the stripping up into small pieces, and pounding them up with glycerine. Leave the mixture for eight days, and then press the fluid through cloth. The glycerine extract so obtained will show all the active properties of pepsin.

Pepsin	Dose 2 to 10 grains with food.
Saccharated Pepsin	,, 5 to 15 ,,
Liquor Pepticus	,, 1 tea-spoonful.
Acid Glycerine of Pepsin	,, 1 to 2 tea-spoonfuls in water.
Pepsin Wine	,, 1 to 2 tea-spoonfuls with food.

Uses.—If a glass beaker or tumbler be taken, a quarter full of water, and if into it be placed some pieces of lean meat, cut very small, small pieces of cooked egg, small pieces of fish, &c., and if there be added to the water a similar quantity of the solution of hydrochloric acid (4°/₀), and a pinch of pepsin, or a tea-spoonful of liquor pepticus, and the glass vessel be then set aside, and kept at a temperature of 100° Fahr., in three or four hours the contents will be partially digested, and the fluid will have acquired a pea-soup appearance and a peculiar odour. If a second tumbler be similarly prepared, and have the same contents, except the pepsin, the fragments of food will show only a swollen gelatinous appearance, no evident solution having occurred; or, if, again, a third tumbler be prepared, and pepsin be added, but no acid, little or no change will occur. In short, for purposes of digestion, both pepsin and acid must be present. If, therefore, one is administering pepsin as an aid to digestion, it is well to give it in an acid solution, in combination, that is, with hydrochloric acid. Now, 6 drops of hydrochloric acid in 1¼ ounce of water give a strength of hydrochloric acid about equal to ·4 per cent, and 6 drops in 2½ ounces of water, or the average sherry-glassful, are equal to ·2 per cent, the exact strength of the acid of the gastric juice, so that 2 to 5 grains of pepsin, 6 drops of dilute hydrochloric acid, and half to one wine-glassful of water would meet the requisite conditions. The cases in which pepsin is considered desirable are those of general debility and anaemia (bloodlessness), where, owing to the general weakness, a deficient supply of gastric juice is the cause of indigestion; and also cases of chronic catarrh of the stomach, such as the chronic dyspepsia of drunkards. It is also needed in cases of irritable stomach, when pain after food is a frequent symptom and subsequent vomiting; in cases of ulceration of the stomach, in which the desire is to relieve the stomach of its work as much as possible; and in the weak digestion of the old and of infants. Of course in the case of children much smaller doses would be employed.

A caution against the routine use of pepsin must be given. It must be noted that if the work of the stomach is done for it, there will be a tendency to lower the activity of the stomach, and if this is long and constantly persisted in, the stomach will become less and less able to do its business. It is, therefore, always desirable to use other remedies to correct indigestion, stimulating remedies with a view to stirring up the stomach to perform its duties, such as the acid or alkaline tonics already noted, combined with tonics to the nervous apparatus of the stomach, such as nux-vomica; and pepsin preparations ought to be employed only for a time to tide over some temporary difficulty. In short, pepsin should be of the nature of a last resort, and never a first.

Liquor pepticus is a solution of pepsin, and may be employed in such cases as pepsin itself. The liquors of Savory and Moore or of Benger are those most widely used.

In cases where it becomes absolutely necessary to relieve the stomach of some or the most of its work by partially digesting the food artificially, such as cases of ulceration of the stomach, and in the case of children, not being nursed by the mother, in whom the stomach rejects cow's milk, condensed milk, and all forms of prepared food, it is customary to effect the object by adding the digestive agent to the food sometime before it is administered, and thus accomplishing the partial digestion before it reaches the stomach at all. Pepsin is not commonly employed for this purpose, because it digests only one class of food-stuffs, namely proteids. The addition of pepsin and acid to milk, for example, would effect only the digestion of the curd of the milk (see p. 549 for composition of milk), and would leave unaffected the cream or fat of the milk. If it were added to a mixture of milk and arrow-root it would not act upon the arrow-root at all, pepsin not digesting starch (see p. 586). When digestion of food is to be accomplished before its administration, therefore, pancreatin or liquor pancreaticus (see below) is employed, since it acts not only on albuminous, but also on starch and fatty foods (see p. 145).

Pancreatin is derived from the sweet-bread or pancreas of the pig. It is a mixture of ferments, one of which is capable of digesting albuminous substances, a second starchy foods, and a third fatty materials. A glycerine extract of pancreas may be prepared by cutting up the fresh sweet-bread of the pig and pounding it up in glycerine, letting it remain so for eight days, and then straining it through cloth. In the market there are several very active solutions of the pancreatic ferments, the best known being the liquor pancreaticus of Savory and Moore and the liquor pancreaticus of Benger. Zymine is a preparation in the form of a yellowish powder obtained from Burroughs, Welcome, & Co., London.

Preparations:

	Dose.
Pancreatin	2 to 4 grains.
Liquor Pancreaticus	1 to 2 tea-spoonfuls in water with a pinch of baking soda 2 or 3 hours after a meal.
Pancreatic Emulsion prepared with the pancreas of the pig and fat and flavoured	1 to 3 tea-spoonfuls in a little milk or water 2 or 3 hours after a meal.

Now a set of experiments with pancreatic solutions may be made in tumblers, such as have been described for pepsin. They show that pancreatin or liquor pancreaticus alone, added to a tumbler containing water and small pieces of food-stuffs, will scarcely act at all. Nor yet will any action whatever occur if acid be added to the solution. But if to the food and pancreatic extract in the tumbler be added a good pinch of bicarbonate of soda, in an hour or two the digestion of the food will be far advanced. That is to say, *while pepsin acts in an acid solution, pancreatic juice requires to be alkaline.* Moreover, if the experiments with the pepsin and pancreatin be kept going side by side, and be carefully watched, two further differences between the digestive agents will be observed. In the tumbler containing the peptic ferment, any fat present will be found floating on the surface of the liquid, and starch will remain unaltered; but in the tumbler with the pancreatic ferment, these as well as the meaty constituents of the food will be found to undergo change. Moreover if the two ferments be left for many hours at work, the tumbler containing the pancreatic ferment will by and by give off an unpleasant odour, showing that the pancreatic juice not only converts all the varieties of food into a condition in which they are fitted to enter the blood, but is capable of acting upon them still further and decomposing them into simpler bodies. In short, a putrefactive change follows that of digestion, which does not occur in the case of pepsin. These facts serve to point out two conditions for the use of the preparations of the pancreas in indigestion.

The first is that it is of little or no use to give pancreatin or liquor pancreaticus by the mouth in a mixture, as one administers pepsin, because as soon as it reaches the stomach it is plunged among an acid fluid and is, therefore, inert. It is possible that it may pass through the stomach unaltered, and when it reaches the small intestine, and the food becomes there alkaline by admixture with the bile, that it then becomes active. But at any rate it is plain that it is useless to give it with the expectation that it will aid digestion *in the stomach.*

When it is given with the desire of reaching the small bowel, it should be given with soda *two hours after a meal.*

The second fact indicated concerning pancreatic preparations is that they will be specially useful for digesting foods previous to administration, since they may be mixed with any kind of food, acting upon all kinds. All that is needful is to mix the liquor pancreaticus *and a pinch of bicarbonate of soda* with the food and keep it warm. Care must be taken that the ferment is not allowed to act too long before the food is to be used, else the food will have acquired an unpleasant bitter taste and perhaps an odour of decomposition. This may be avoided by using the food a short time after the ferment has been added, 20 to 30 minutes, or by boiling the food after that interval, which destroys the ferment, hinders any further action, and, therefore, permits the food to be kept as long as may be necessary.

A few directions for the use of liquor pancreaticus, the most commonly used preparation, may here be given.

For Milk.—To four tea-cupfuls of milk add one tea-cupful of cold water, divide the mixture into two equal parts, bring one-half to the boiling point, then mix the boiling portion and the cold portion together. This gives the mixture a temperature favourable to the action of the ferment. Now add a tea-spoonful of liquor pancreaticus and a good pinch (15 grains) of bicarbonate of soda: stir the mixture, and set it aside in a warm place (where it will simply be kept warm, without being made hotter) for 30 minutes. Then boil, and use as required.

For Tapioca, Rice, Sago, Corn-flour, Porridge, Gruel, or similar preparation.—Make the tapioca, gruel, or whatever it may be in the usual way but very thick. Mix thoroughly a tea-cupful of the food, when quite ready and boiling hot, with the same quantity of cold milk. Then add one or two tea-spoonfuls of the liquor pancreaticus and the large pinch of soda; mix well; set in a warm place for 20 to 30 minutes. If the solution is acting properly, the thick mixture will become perfectly fluid, and it may be immediately supped, as it is, or after being boiled.

For Beef or Chicken Tea.—The lean beef or chicken should be scraped down into a pulp, as ordered for beef-tea (see p. 627), mixed with the proper quantity of water, and brought up to a blood-heat (100° Fahr.). Then stir in 2 or 3 tea-spoonfuls of liquor pancreaticus with half a tea-spoonful or thereby of bicarbonate of soda—that is to 1 lb. of meat scrapings and 4 breakfast-cupfuls of water. Keep the mixture at the temperature named for 1 hour or 1½ hour, tasting it from time to time, however, to see that the action of the ferment is not proceeding too far to the development of a disagreeable flavour; after a sufficient time boil, and use as required. If it is desired to thicken the beef-tea with flour, arrow-root, &c., such should be separately prepared, properly boiled, and then added to the cold meat and water, and when a proper temperature is secured, the ferment is added. The starch of the arrow-root, &c., will thus also be acted on. These directions will enable one to prepare and artificially digest almost any kind of food. It may be added that the London chemists, Burroughs, Welcome, & Co., put up their pancreatic powder, called zymine, in glass tubes along with the necessary soda, in quantity sufficient for the predigestion of one pint of milk. They are called **peptonizing powders.**

Liquor pancreaticus is especially valuable for adding to preparations of food used for injecting into the bowel in cases where food cannot be taken by the mouth. Thus milk may be prepared lukewarm with the addition of two tea-spoonfuls of the liquor and a large pinch of soda, and injected. A mixture of boiled arrow-root and strong beef-tea with the liquor pancreaticus and soda may be similarly used (see p. 873, for other nourishing injections).

Papain is a digestive ferment derived from the juice of the papaw-tree, *Carica Papaya.* It acts on albuminous food like pepsin. "The fruit of the papaw-tree has long been used in the West Indies to render beef tender. The unripe fruit is split open and rubbed over the surface of the meat previous to cooking."

Uses.—Papain is not very extensively used for indigestion, though it is useful in cases to which pepsin is applicable. It has been more largely used to dissolve warty growths and false membranes. The author has found it dissolve the false membrane of diphtheria with great rapidity in several cases. The solution recommended contains 12 grains of papain, 5 of borax, and 2 drachms of water, and it is painted on with a camel-hair pencil twice daily or oftener. In one or two days the membrane comes away on the brush in large portions. In urgent cases it might be used every hour or even oftener.

Ingluvin is a special American preparation, said to be prepared from the gizzard of the domestic fowl. Though recommended as a substitute for pepsin it has not been shown to have much action on coagulated egg albumen. It has been recommended specially for obstinate vomiting, and in particular for the vomiting of pregnancy. The dose is from 5 to 10 grains.

Lactopeptine is another preparation of ferments vaunted in the treatment of dyspepsia and other chronic affections of the stomach. Its dose is 10 to 15 grains.

Remedies for Flatulence of the Stomach.

The distension of the stomach with wind is a consequence of some kind of improper digestion. If the proper fermentive process does not take place, changes of decomposition occur, with the development of gas, and painful distension results, which by pressure interferes with neighbouring organs and specially the heart. The obvious remedy for this state of things is that which will correct the error of digestion, for if natural digestion be restored the production of gas will not occur. To this end probably the alkaline tonic with aromatic spirit of ammonia and a bitter tonic (see p. 844) taken before food would be useful. But while the discomfort and pain of the flatulence are present, the desire is for some means of exciting the stomach to expel the wind. There are many drugs which do this, but it is well to insist on the fact that they can afford only temporary relief. They dispel the wind at the time, but they give no guarantee that an hour or two after the next meal the same state of things will not be repeated. Every sufferer in this way ought, therefore, to seek to find some more permanent relief by finding some remedy for the improper digestion which is the cause of the disturbance. Substances which aid in the expulsion of gas from the stomach do so by stimulating the movements of the stomach wall, and it may be causing the communication between the lower end of the gullet and stomach to dilate so as to allow of the escape of the gas. Such substances are called **carminatives,** and they are usually aromatic substances such as allspice, anise, assafœtida, camphor, cinnamon, cloves, cayenne, caraway, cardamoms, coriander, dill, ginger, horse-radish, mace, mustard, nutmeg, pepper, peppermint, valerian, and stimulants, like ether alcohol and chloroform, and ammonia.

We shall give a list of the chief of their preparations and doses, and shall afterwards consider a few of them in more detail.

	DOSE.
Oil of Anise	2 to 5 drops on sugar.
Essence of Anise	10 to 20 drops.
Water of Anise	½ to 1 tea-spoonful.
Tincture Assafœtida	½ to 1 tea-spoonful.
Fœtid Spirit of Ammonia—Assafœtida 1½ ounce, strong solution of Ammonia 2 ounces, Spirit (proof) 20 ounces	½ to 1 tea-spoonful.
Pill Assafœtida	1 to 2 pills.
Compound Assafœtida Pill	1 to 2 pills.
Enema Assafœtida	30 grains powdered Assafœtida in 4 ounces of water.
Oil of Cajuput	1 to 3 drops.
Spirit of Cajuput	30 to 60 drops.
Camphor Water	1 tea-spoonful.
Oil of Caraway	2 to 5 drops.
Water of Caraway	1 to 2 ounces.
Compound Tincture of Cardamoms	½ to 2 tea-spoonfuls.
Tincture of Cayenne	2 to 10 drops well diluted.
Cinnamon Water	1 to 2 ounces.
Oil of Cinnamon	1 to 4 drops.
Compound Cinnamon Powder (Aromatic Powder)	3 to 10 grains.
(Equal quantities of Cinnamon, Cardamoms, and Ginger.)	
Tincture of Cinnamon	½ to 2 tea-spoonfuls.
Oil of Cloves	1 to 4 drops.
Infusion of Cloves	1 to 2 ounces.
Oil of Coriander	2 to 5 drops.
Powdered Coriander	20 to 60 grains.
Oil of Dill	1 to 4 drops on sugar.
Dill Water—The best for children	1 to 4 tea-spoonfuls in water.
Fennel Water	1 to 2 ounces.
Ginger Powder	10 to 20 grains.
Essence of Ginger	5 to 20 drops.
Syrup of Ginger	1 to 4 tea-spoonfuls.
Tincture of Ginger	10 to 30 drops.
Compound Spirit of Horse-radish	1 to 2 tea-spoonfuls.
Oil of Nutmeg	2 to 6 drops.
Spirit of Nutmeg	30 to 60 drops.
Oil of Pimenta (Allspice)	1 to 3 drops.
Pimenta Water	1 to 2 ounces.
Peppermint Water	1 to 2 ounces.
Oil of Peppermint	1 to 5 drops.
Essence of Peppermint	10 to 20 drops.
Spirit of Peppermint	15 to 30 drops.
Oil of Spearmint	1 to 5 drops.
Water of Spearmint	1 to 2 ounces.
Spirit of Spearmint	5 to 20 drops.
Infusion of Valerian	1 to 2 ounces.
(120 grains Valerian Root infused for 1 hour in ½ pint of boiling water.)	
Tincture of Valerian	1 to 2 tea-spoonfuls in water.
Ammoniated Tincture of Valerian	½ to 1 tea-spoonful.
Aromatic Spirit of Ammonia (see p. 843).	

These substances act by exciting the circulation in the stomach, causing a sense of heat and increased appetite, and aiding the digestion of food. They excite the nerves and relieve pain, and by stimulating the muscular movements of the stomach help to expel wind. An excellent combination for this would be half a tea-spoonful of aromatic spirits of ammonia, a few drops of tincture of cayenne, and a tea-spoonful of bitter infusion in half a wine-glassful of water.

Most of these remedies are also useful in the relief of spasm or cramp of the stomach or bowels. This consists in irregular and excessive contraction of part of the muscular wall of the intestinal tube. The remedy relieves it by exciting the natural movement as a whole, causing expulsion of the cause of irritation. These remedies are, therefore, also called **anti-spasmodics.**

Assafœtida as used in medicine is a gum resin obtained from the root of *Narthex assafœtida*, an umbelliferous plant, native of Persia, Afghanistan, and the Punjaub.

It is a powerful stimulant to the nervous system, very valuable for the relief of spasm, specially of a hysterical kind. Its unpleasant odour is the only objection to giving it for relief of flatulent distension of the stomach. This objection is overcome in the case of the bowels by giving it as an enema (see p. 874). It is valuable in hysterical affections at the period of change of life; and its antispasmodic effects are likewise available in whooping-cough, asthma, and other nervous diseases.

Anise, the fruit of *Pimpinella anisum*, **Fennel,** the fruit of *Fœniculum dulce*, imported from Malta, **Dill Fruit,** the dried fruit of *Anethum graveolens*, **Caraway,** the dried fruit of *Carum Carui*, **Coriander,** the dried ripe fruit of *Coriandrum sativum*, are substances all belonging to the same natural order—*Umbelliferæ*, and all yielding preparations which have similar effects on the body and are used for similar purposes.

They have all a stimulating effect upon the stomach and bowels. They may be used alone to relieve flatulence, and one or other is commonly given along with purgatives to diminish any tendency to griping. Anise and dill are specially used for children, for whom they are very useful.

Cloves belong to the *Myrtaceæ* order of plants and may be taken as a representative of this class of remedies. From all of them an aromatic essential oil may be distilled, which possesses the chief qualities of the remedy. These essential oils, when applied to the skin, redden it, causing smarting at first, but later diminishing the sensibility of the part. They prevent decomposition. When taken internally, they act upon the mucous membrane of mouth, gullet, stomach, and bowels, as they act upon the skin, producing stimulation of nerves, exciting a freer flow of blood, causing increased appetite, and increased digestive power, relieving pain, hiccup, &c., and aiding in the expulsion of wind. Oil of cloves is used as an application for toothache because of its soothing effects following the first stimulating effect.

Cajuput is derived from the leaves of *Melaleuca minor* or cajuput-tree, growing in the Molucca Islands, the oil being imported from Batavia and Singapore. It and **allspice** or pimenta belong to the same order as cloves, and have similar actions.

Cardamoms and **Ginger** belong to the same natural order (see p. 594). They are both of them widely used as remedies for flatulence, usually in combination with other medicines, such as tonics. For example, the compound tincture of cardamoms or the tincture of ginger would be a useful addition to a tonic for indigestion.

Camphor is a solid volatile oil, obtained from the wood of *Camphora officinarum*, belonging to the same order as cinnamon, Lauraceæ. Rough camphor is imported from China and Japan and is re-sublimed in England.

Use.—It stimulates the skin and is a powerful irritant to raw surfaces and to mucous membranes. On this account it is employed for liniments and oils, as applications to sprains, painful and enlarged joints. It is destructive to low forms of animal life, and is used, therefore, for antiseptic purposes, along with carbolic acid, for decayed teeth, &c. It is its stimulating properties that make it useful, when taken internally, for flatulence and diarrhœa, in hysterical vomiting and the early stage of cholera. But when given in large doses it produces sickness and vomiting, by its irritant effects. It also stimulates the heart and circulation, when taken internally, and the nervous system. Because of its stimulating effects on the nervous system, it has been given in prostration of fevers, in poisoning by opium, and in various nervous affections. In overdoses it produces a species of intoxication, with confusion of speech and mind, and later convulsions. It stimulates the air-passages also, and is frequently used in combination with other substances as a cough mixture, and it acts also on the skin. In common cold-in-the-head it has been found useful when inhaled as a vapour, 30 to 60 grains in ½ pint hot water.

Its chief preparations are:—

	Dose.
Camphor Water	1 tea-spoonful.
(Place 30 grains crushed camphor in a small muslin bag in 1 pint of water for 2 days.)	
Spirit of Camphor	10 to 30 drops.
Compound Tincture of Camphor	15 to 30 drops.
(Contains opium—used for cough, and called Paregoric Elixir.)	

Cinnamon (see p. 595) is specially useful in combination with drugs for diarrhœa, because, besides its aromatic oil, it contains tannic acid properties, and has therefore an astringent as well as a stimulating action on the stomach and bowel.

Peppermint (see p. 594) is one of the most common remedies for flatulence and colic, either alone or in combination with purgatives, or, in cases of diarrhœa, with astringents. Rubbing the skin of face and hands and other exposed parts with soap strongly scented with peppermint or lavender prevents mosquito bites. Hanging a sprig of the plant or of pennyroyal near the head during sleep is said also to be useful, or a small bottle containing the volatile oil.

Spearmint has similar properties to peppermint.

Valerian—the dried roots and rootlets of *Valeriana officinalis*, plants growing wild and cultivated in Britain. The preparations of valerian have a strong stimulating effect upon the stomach and bowels, heart and nervous system. It is specially used for hysterical flatulence, fainting, palpitation, and convulsions. In large doses the oil paralyses the nervous system.

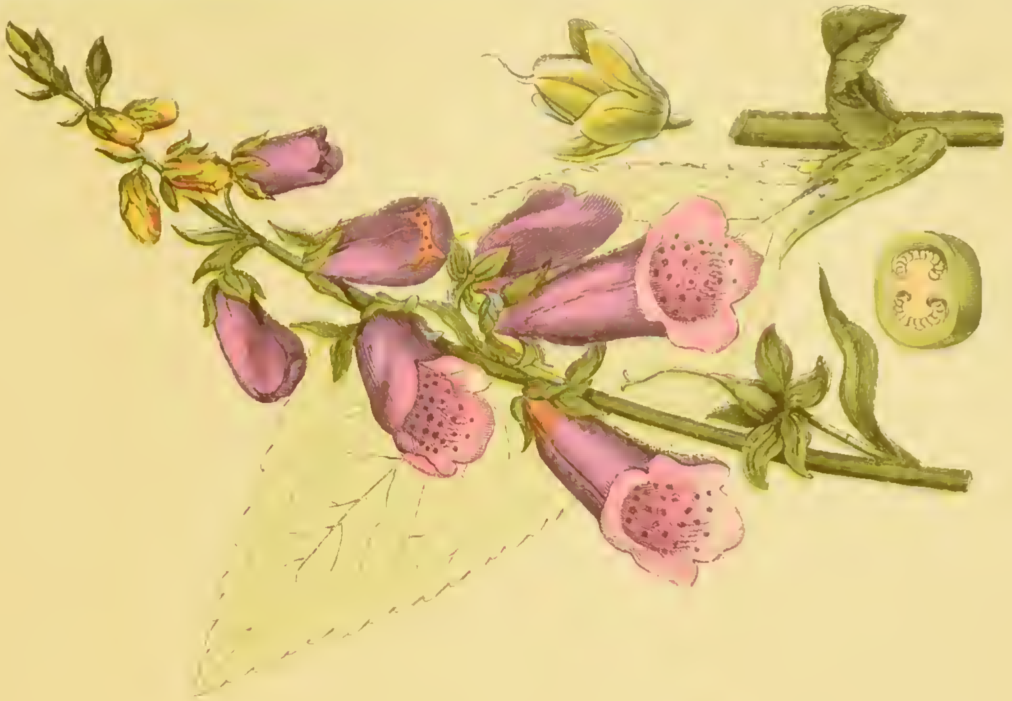
Besides these remedies creasote, sulphurous acid, and carbolic acid have been given for flatulence, and also charcoal. The idea of using the three former substances is that they prevent changes of decomposition occurring which may be the cause of the flatulence. They may be tried in drop doses diluted. The object of using charcoal is to diminish distension by the absorption of the gas. For this purpose a half tea-spoonful of the powder may be used.

Emetics.

These are substances which cause the stomach to expel its contents by way of the mouth (Greek *emeo*, to vomit). Some substances produce this action by influencing the stomach itself, by an irritating effect upon its walls. This is the way in which mustard acts, for example, car-

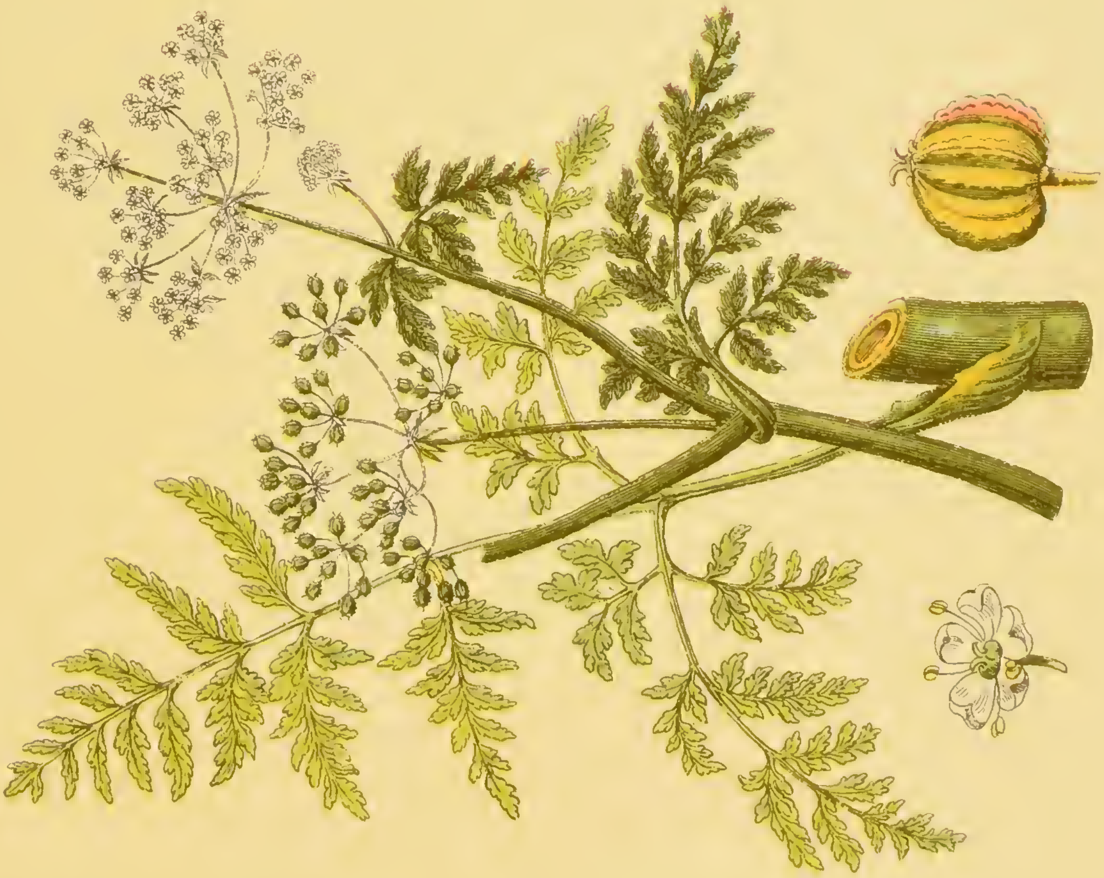
COMMON POISONOUS PLANTS.

Plate XI.



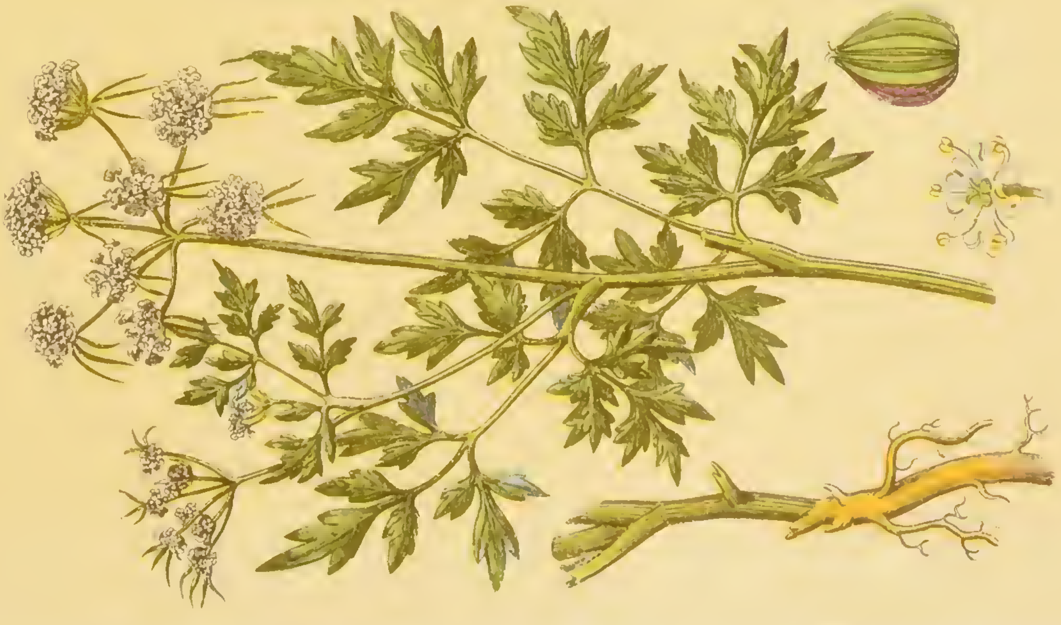
PURPLE FOXGLOVE or FOLKSGLOVE

(Digitalis Purpurea)



COMMON GREATER or SPOTTED HEMLOCK

(Conium Maculatum)



FOOL'S PARSLEY or LESSER HEMLOCK.

(Æthusa Cynapium)

bonate of ammonia in large doses, infusion of chamomile flowers, salt and water, sulphate of zinc, alum, and sulphate of copper. Large draughts of warm water act by their mechanical bulk. These are called **direct emetics.** On the other hand there are a few drugs which excite vomiting by acting on the nervous system, and may produce their effect without entering the stomach at all, such as, among others, tartar emetic, ipecacuanha, apomorphia. That vomiting may be principally dependent upon nervous changes is shown by the fact that mere impressions upon the nerves of sight, taste, smell, may excite it, or the mere idea or recollection of such impressions, as the recollection of a disgusting smell or sight, &c., and by the fact that vomiting is a very common symptom in irritation of the brain, as in inflammation of the membranes of the brain, and the pressure of tumours or effusions on the brain. Then the induction of vomiting by tickling the throat with a feather, or by passing the finger into the throat, is an illustration of reflex nervous vomiting. The occurrence of vomiting in disease of kidneys, ovaries, womb, &c., is another illustration of the same thing, the stomach being acted on by nervous impressions conveyed from the diseased organ.

It is to be noted that vomiting is not a simple act of expelling the contents of the stomach. Other organs are influenced more or less, according to the nature of the agent used to excite the act. Usually there is general depression, enfeeblement of the circulation, weakening of the action of the heart, languor, and muscular weakness. The air-passages are affected, air being pressed out of the lungs by the compression of the abdomen. In bronchitis, croup, and other diseases of the air-passages, this effect is beneficial by clearing the tubes of phlegm, &c. Often, moreover, the emetic used has a stimulating action upon the respiratory passages, such as ipecacuanha, so that the sweeping out of material from the lungs is more effectually secured. The act of vomiting is also accompanied by increased secretion of sweat, saliva, and mucus from the glands of the throat and air-passages. The pressure exerted upon the abdomen in the act of vomiting expels bile from the gall-bladder, and is sometimes made use of to get rid of gall-stones lodging in the bile-duct. Now it will be understood that the additional effects on the heart and circulation, lungs and nervous system, are much more marked in the case of drugs which act through the general system, and much less marked, or not marked at all, in the case of emetics acting simply locally on the stomach. Mustard and water given for the purpose of emptying the stomach and getting rid of a mass of ill-digested and irritating food will rather produce a sense of comfort and well-being than a feeling of depression. Tartar emetic, on the other hand, produces great depression, and might cause serious weakening of the circulation and collapse in delicate persons. Therefore, in selecting an emetic, one ought to consider the other effects the emetic may produce, and whether it is advisable, in the particular case, to risk them or not. The mere increased pressure upon certain organs, specially upon the lungs and blood-vessels, must not be forgotten, and it will show the need of refraining from the use of such substances in the case of persons with weak blood-vessels, liable to attacks of bleeding.

We will now consider some of the details connected with the action of the drugs used as emetics.

Lukewarm Water given in large draughts is one of the simplest and safest of emetics, and may be used to rid the stomach of irritating masses of food, in sick headache, or to aid in the expulsion of some piece of food lodged in the upper part of the gullet. Salt and water, a table-spoonful in a tumbler of warm water, are also employed for a like purpose.

Mustard and Water.—One or two tea-spoonfuls of mustard to a tumblerful of hot water is more expeditious than simple lukewarm water, and is employed under similar circumstances. It is the means most ready to hand in cases of poisoning, and in cases of laudanum-poisoning it is to be preferred to sulphate of zinc or copper, since the laudanum may so deaden the susceptibility of the stomach walls that it is impossible to induce vomiting, and the use of the stomach-pump may be necessary. In such a case the substance given as an emetic remains in the stomach and may be absorbed. In the case of mustard no harm will be done; in the case of zinc, &c., harm might arise.

Infusion of Chamomile Flowers.—Emetic dose, 5 ounces or upwards. See p. 840.

Carbonate of Ammonia.—30 grains in water, as an emetic. See p. 843.

Zinc.—The chief preparations of zinc used as emetics are as follows:—

Sulphate of Zinc....	Emetic dose,	10 to 30 grains.
Acetate of Zinc.......	,,	10 ,, 20 ,,

Sulphate of zinc is employed as an emetic when an effect is speedily desired. Besides rapidity of action, very necessary in cases of poisoning, it possesses the property of producing little depression. It is chiefly in cases of poisoning it is employed.

Preparations of zinc are also employed for their tonic and astringent properties, and are considered further on p. 869.

Copper.—

Sulphate of Copper.........Emetic dose, 5 to 10 grains.

Preparations of copper are chiefly used for external application, but some of its salts are noted on p. 869 later in this section. As an emetic the zinc sulphate is preferred.

Alum.—

Dried Alum......Emetic dose, 30 to 60 grains.

Alum is mainly used as a local application, for washes, gargles, &c., and is considered further on in this section (p. 868).

Ipecacuanha belongs to that class of emetics which act upon the general system. It will be suitable here to consider all its actions upon the body, and the chief preparations. The plant is called the *Cephaëlis Ipecacuanha*, and it is the dried roots that are used. These are dull-gray, bent and twisted, with a thin, white, finely-porous core, and a thick wrinkled bark, presenting the appearance of a series of rings threaded on to the core. The root is powdered, and besides starch, gum, &c., contains the active principle emetin and ipecacuanhic acid, a substance allied to tannic acid.

Preparations:—

	DOSE.
Powdered Ipecacuanha	$\frac{1}{2}$ to 2 grains as expectorant. 15 to 30 ,, emetic.
Ipecacuanha Wine....	5 to 40 drops as expectorant. 3–6 tea-spoonfuls as emetic.
Compound Ipecacuanha Powder (Dover's Powder) (1 grain of Ipecacuanha, 1 grain of Opium, 8 grains Sulphate of Potash),.	5–10 grains (*for adults only*).
Syrup Ipecacuanha (an American preparation)	2 to 30 drops as expectorant. $\frac{1}{2}$ to 1 ounce as emetic.

Ipecacuanha powder has marked irritating properties. Dust of ipecacuanha in process of grinding gaining entrance to the nostrils, and air-passages in general, produces all the symptom of a severe cold in the head, sneezing, swelling of the lining membrane of the nostrils, coughing, and a species of hay-asthma; and it may even produce a pustular eruption. When the wine is used as a spray to the throat, its stimulating qualities cause increase of the secretion of the throat glands, and relieve dryness of the parts and cough and irritation arising therefrom. Taken into the stomach it produces similar effects. If the dose be small, it acts as a stimulant to the stomach, and produces frequently marked beneficial results by the stimulus, specially in catarrhal conditions of that organ. In larger doses it excites sickness and vomiting by the marked irritation it produces. It acts very quickly, and for this purpose a good method of administration consists in giving 5 grains of the powder in water every 5 minutes till the effect is produced. Gaining entrance to the blood, it acts on the lining membrane of the air-passages, increasing the phlegm, and rendering it more fluid. It is thus specially in cases where the expectoration is scanty or tough and expelled only with difficulty that ipecacuanha should be employed. It is widely used in bronchitis of children to aid in the removal of the phlegm, and in whooping-cough also. It acts also on the skin, and in common colds, in combination with opium as Dover's powder, it is one of the best of remedies. It is employed also for its effect on the liver by increasing the secretion of bile, and for its stimulating effects on the bowel in dysentery. Its praises have been sung in the acute dysentery of the tropics. For this purpose it must be given in large dose—30 to 90 grains, and it is said such doses may be given in this disorder without inducing vomiting, if the patient will keep lying quietly on the back. In suitable cases the motions become natural in character and frequence, and straining and griping disappear. After a large dose—60 to 90 grains—a second will not be required for 10 to 12 hours, if any second be needed at all. Instead of being given by the mouth it may be injected into the bowel—30 to 60 grains suspended in a small quantity of gummy fluid, three or four times a-day. It is also worth trying in the diarrhœa of children, when the stools are slimy and green. One or two drops of the wine every hour are recommended; and all the more if vomiting also be present. It may appear strange that a drug given to produce vomiting should also be able to allay vomiting, but it appears to yield much relief in some forms of the vomiting of pregnancy, that form which occurs soon after waking, and also in those cases where sickness, heartburn, and flatulence are associated. One drop of the wine every hour or several times a-day is recommended by Ringer for this purpose, and for the morning sickness of drunkards. The vomiting due to cold-in-the-stomach—gastric catarrh—which is frequently also attended by purging, will almost certainly be relieved by a dose of the Dover's powder, repeated in 3 or 4 hours. A spray of ipecacuanha wine is highly recommended by Dr. Ringer to relieve the cough, tightness of the chest, and difficult breathing of "winter cough." The person should breathe deeply at every squeeze of the spray-ball to get the vapour well into the air-passages, and two or three squeezes should be used at each sitting, and repeated twice daily or so.

Emetin, the active principle of ipecacuanha, is used as an expectorant in doses of $\frac{1}{200}$ grain and as an emetic in doses of $\frac{1}{6}$ to $\frac{1}{3}$ grain. It is very powerful, and not to be used except by medical orders.

Tartar Emetic—Antimony.—Antimony is a metal. It is not employed in medicine in its metallic state. Its chief preparations used in medicine are:

Tartar Emetic or Tartrated Antimony....	Dose, as an expectorant $\frac{1}{16}$ to $\frac{1}{6}$ grain, as an emetic 1 to 2 grains.
Antimonial Wine..................................	,, to cause sweating 10 to 40 drops, as an emetic $\frac{1}{2}$ to 1 teaspoonful repeated.
James's Fever Powder (1 part of Oxide of Antimony with 2 of Phosphate of Lime).	,, 3 to 10 grains.

Another preparation of antimony, the "butter of antimony," properly the solution of the chloride of antimony, is used by veterinary surgeons for application to foul sores and malignant surfaces to cleanse them. An ointment of tartar emetic (1 of tartar emetic to 4 of lard) is used for enlarged joints, in cases of neuralgia, and as a stimulating application to the chest in bronchitis, whooping-cough, &c.

Uses.—The ointment of tartar emetic applied to the skin reddens it and brings out a crop of pimples which become pustules. It is irritating, that is to say. Now when tartar emetic is taken into the stomach in *small quantity*, it is mildly irritating, producing a feeling of warmth at the stomach; sweating also follows. In slightly larger doses the irritating action produces loss of appetite, sickness, weakness of the circulation, and a feeling of feebleness and depression. At the same time the secretion from the glands of the stomach, bowels, respiratory passages, and skin is increased. After larger doses vomiting occurs with great weakness and depression and muscular relaxation, and after poisonous doses the symptoms of irritation of stomach and bowels are marked. There occurs diarrhœa, the pulse is small and quick, and the skin is covered with cold clammy sweat. The symptoms are very like those of cholera, cramps of the extremities also occur, and before death sometimes delirium and convulsive spasms.

Tartar emetic is used chiefly for its emetic and depressing properties, but it is not resorted to now nearly so much as formerly. On account of its marked effect in reducing the strength and frequence of the pulse it used to be much employed at the beginning of fevers, and during the course of acute inflammations of lung, bowels, brain, &c. Its effect in stimulating the skin made it still more useful in these conditions. For these objects, however, it is scarcely now employed, except in acute inflammations in otherwise perfectly healthy and robust persons. To cause vomiting in order to get relief in bronchitis or croup or whooping-cough, ipecacuanha is preferred. Emetics have been found very useful to cut short attacks of malarial fever, such as ague, when accompanied by a purgative and followed by the administration of quinine.

Antimony in any of its forms should never be administered to the very young, very old, or feeble; and indeed what has been said ought to be sufficient to deter unskilled persons from its use.

Plummer's Pill is a mixture of calomel, sulphurated antimony, guaiacum resin, and castor-oil, and the presence of the antimony is supposed to increase its stimulating effect upon the liver, causing an increased outpour of bile into the bowel.

The use of antimony sometimes brings out a pustular eruption on the skin.

Poisoning by antimony is to be treated by administering solutions of tannin, easily obtained from strong infusions of tea, or oak-bark, or cinchona. Stimulants ought also to be given to relieve depression, diffusible stimulants like ammonia being preferred.

Apomorphia is made from morphia by heating it in a closed tube with concentrated hydrochloric acid. It is one of the most certain of emetics, and causes neither irritation of the stomach nor diarrhœa. It induces vomiting, not by acting on the stomach, but by its influence on the nerve-centres, and as the dose is small it can be injected under the skin by the hypodermic method (see p. 813). The dose, when thus used, is $\frac{1}{20}$ to $\frac{1}{10}$ grain. If taken by the mouth, a dose of $\frac{1}{10}$ to $\frac{1}{6}$ grain is required. In a few minutes after injection there is sickness, not excessive, and free vomiting, and depression does not last long. Apomorphia is now employed when speediness of action is desired, as in cases of poisoning, and in cases of lodgment of foreign bodies or masses of food in the gullet. It is not a substance, however, to be employed by any but a skilled person, and certainly not in the case of children, except by some responsible person who is well acquainted with the materials he is using.

Remedies which Soothe the Stomach.

All the substances which we have been hitherto considering in this section act as stimulants to the stomach, increasing the activity of its circulation, the energy of its movements, and the excitability of its nerves. It is very frequently necessary to produce quite contrary effects, to diminish the circulation, to quiet the churning movements, and to dull the nervous sensibility. Remedies which do this are called **gastric sedatives.** The indications for the need of such treatment are an excessive irritability, which causes the stomach to eject its contents by vomiting, or to threaten to do so, pain, and sometimes diarrhœa, caused by the food being hurried out of the stomach before it has time to be digested, a kind of diarrhœa which is recognized by its being almost invariably set up a very short time or only a few minutes after food is taken. Substances which thus soothe the stomach may do so directly. For example, if marked irritability of the stomach be due to excessive acidity of its contents, a few grains of bicarbonate of soda, by neutralizing the excess of acid, will procure relief and quiet down the organ. In like circumstances a glass of warm water is often sufficient to procure relief. Or if the irritability be due to flatulent distension, some of the agents for expelling wind—ginger, peppermint, &c.—may have a similar calming effect. This action is due to the direct influence on the stomach itself and its contents. On the other hand, other remedies act in a more general way, through the blood and nervous system. Opium is an excellent example of this class, acting as a sedative to the stomach by its effect upon the nerves.

Ice is the most powerful of local sedatives to the walls of the stomach. It is simple, and in cases of pronounced irritability, evidenced by the vomiting of everything taken, no matter how small in quantity, ice should be resorted to. The ice should be swallowed in small pieces, and milk ought to be iced and sips taken at frequent intervals. The application to the walls of the abdomen over the region of the stomach of mustard poultices will aid the treatment materially.

Bismuth is one of the chief local soothing agents in stomach irritability. Bismuth is a metal; its chief preparations are as follows:—

Carbonate of Bismuth	Dose, 5 to 20 grains.
Subnitrate of Bismuth	,, 5 to 20 ,,
Bismuth Lozenges	,, 1 to 6 lozenges.

2 grains of subnitrate in each lozenge.

Uses.—Bismuth in the form of subnitrate is used to allay irritation outside the stomach, as a dusting powder, wash, or ointment to chapped hands and nipples, and to weeping sores such as the raw surface of eczema. Used as snuff it is very valuable in the commencing stage of cold in the head, the stage when the irritability of the lining membrane is so great that sneezing is occasioned by the slightest movement of air. It is best combined with morphia and powdered gum arabic as Ferrier's snuff (see p. 155). In 10-grain doses the subnitrate, or still better the carbonate, of bismuth is one of the best remedies in irritable indigestion, of which pain squeamishness and vomiting are the signs. In the beginning of cold in the stomach—gastric catarrh—when everything is rejected, and there is headache, bone-pains, and feverishness, bismuth with opium in the form of Dover's powder commonly acts like a charm. If it is not desirable to give opium, for example to young persons or to those with whom opium disagrees, it may be combined with one of the preparations of lime or magnesia. A solution of bismuth is now obtainable from all chemists, which may be used for children, and the dose of which is from ½ to 1 teaspoonful for adults. The drug is as useful for irritable conditions of the bowel, diarrhœa, dysentery, &c., and specially for the diarrhœa coming on suddenly after a meal.

Dilute Hydrocyanic Acid.—A solution of prussic acid. Pure prussic acid is one of the most powerful poisons, a single drop let fall into the eye, nose, or mouth of a small animal killing it instantly by its action on the heart and breathing through the nervous system. The dilute acid contains 2 per cent by weight of the pure. Poisonous doses paralyse the brain, nerves, and muscles. If the strong acid be applied to the skin it renders the part numb, abolishing in it the sense of touch by passing through the horny layer and paralysing the sensory nerves, and the dilute acid, applied for a time, will produce a like effect. It is this action which renders it a valuable drug for depressing the sensibility of the throat and stomach and allaying irritability. When a dose of the weak acid is taken into the mouth it produces a dulling effect upon the throat and gullet, and a soothing influence on the stomach. For these purposes the dose of the dilute acid is 2 to 8 drops.

Poisonous doses, not large enough to kill instantly, produce slowness of breathing, difficulty of breathing, symptoms of suffocation, and death, after convulsions, by suffocation, all this owing to paralysis of the nerve-centre presiding over the movements of breathing. Headache, mental confusion, and stupor are also among the symptoms. In cases of accidental poisoning the person must be taken into the cold air, artificial respiration must be used, and sluicing with cold water. Freshly-prepared oxide of iron along with carbonate of soda, potash, magnesia, or lime is an antidote.

Dilute hydrocyanic acid is never prescribed alone, but always in combination with other substances of a sedative kind, such as bismuth, solution of morphia, and so on. Besides in cases of irritable dyspepsia, it is used for dry irritable cough, and to relieve the hacking cough of consumption and the asthmatic cough. It is also employed as a wash, ¼ ounce to 8 ounces of rose-water, for itching of the skin, or in combination with zinc ointment—30 to 60 drops to each ounce—for a like purpose.

Among other sedatives to the stomach are—**Belladonna** and its active principal **Atropine**, **Opium** and its active principal **Morphia**, which are discussed in the section devoted to Drugs Acting on the Nervous System.

Oxalate of Cerium is another drug, given in doses of 1 and 2 grains as powder for vomiting, specially the vomiting and heartburn of pregnancy. It is not, however, very reliable.

Chloroform, Ether, and Cocaine, discussed elsewhere, are also gastric sedatives.

Sulphurous Acid, Creasote, Carbolic Acid, in 1-drop doses in water, also allay irritability of stomach when it depends on processes of fermentation set up within the stomach.

Ice and bismuth with the outward application of mustard poultices are the remedies to be commonly employed for allaying stomach irritability, of course after any irritating substance has been expelled, and combined with the administration of bland soothing food, in small quantities.

DRUGS WHICH ACT ON THE BOWELS.

A large portion of what has been written in the previous part of this section is as applicable to the bowel as to the stomach itself. The bowel may be stimulated by the same means which stimulate the stomach, such means as excite a more lively circulation or a more vigorous movement, such as bitter and aromatic tonics. The same remedies which are useful in expelling wind from the stomach will help in dispersing it from the bowel, and the drugs which exert a sedative influence on the one will do so on the other also. Then the whole bowel will be markedly influenced by the state of the stomach. If the contents of the stomach have left it in an irritating, intensely acid, acrid condition, they will prove very irritating also to the small bowel, which they enter; and the acidity may not be sufficiently neutralized to allow of the digestion by the pancreas and the bile to go on satisfactorily. An ill-digested mass will consequently be passed along the bowel, producing irritation as it goes, ending, it may be, in irregular contraction of the bowels, colic, and hasty expulsion of the offending materials by a too copious discharge. This condition of affairs the administration of some alkaline medicine, soda or potash, while the food was still in the stomach, would have greatly diminished, if not prevented, by diminishing the excessive acidity. On the other hand, if, through weakness, the gastric juice has been deficient, the contents of the stomach have not been acid enough, the absence of the usual stimulus of the acid material passing over the openings of the bile and pancreatic ducts might lead to a diminished flow of the respective juices and to a continuance of the imperfect digestion already begun in the stomach. So that we may say the proper performance of digestion in the stomach is the necessary preparation for proper digestion in the upper part of the small intestine. There remain, then, for our consideration, two large classes of drugs affecting the bowel, namely those which assist in the expulsion of the remains of the food and other contents from the bowel, and those which restrain such an action, in short purgatives and astringents, remedies for constipation and for diarrhœa.

Remedies for Constipation: Purgatives, &c.

When one considers on what conditions the regular onward progress of the altered foods in the bowel depends, it becomes easier to understand in how great a variety of ways constipation may be produced and after how many different methods it may be treated. To the altered food as it passes along the bowel, there are added various juices, the bile, pancreatic juice, and intestinal juice, dependent as to quantity upon the blood supply to the organs manufacturing them, and upon the stimulus received from the food itself. From this mixture of food and digestive juices there is being removed, in liquid form, as it passes along, much of its nutritive material, and the consistence of the mass in its onward progress will depend on the relation between the addition of fluid and the abstraction of dissolved nutriment. Defective secretion and slow progress will produce a very dry residue, little being added and as much as possible abstracted, while hurried progress will make a very fluid residue, because little time is given for absorption; and such hurried progress is usually the result of irritation, which will have, as another of its effects, a more copious secretion. The onward progress is due to the worm-like spiral wave of contraction that passes along the bowel always in one direction—the peristaltic movement, and this movement depends for its rate and its energy upon the excitability of the muscular wall of the bowel and on the state of the nerves between the muscular layers. It remains to be added that the bile, besides aiding the movement merely by its watery character, does so also by the stimulating action it has upon the bowel, increasing thereby the peristaltic contraction. It is plain, therefore, that the movement of the remains of food-stuffs along the digestive canal will be aided by any substance which (1) increases the quantity of the digestive fluids, or (2) drains water from the blood into the canal, or (3) increases specially the quantity of the bile, since it is particularly stimulating, or (4) increases the movement either by directly exciting the muscular walls, or indirectly by acting through the nerves. Now, there are drugs capable of accomplishing one or other of these actions, and some of them act at the same time in several of the ways indicated. Certain terms are employed to signify the special way in which the remedy acts. The general term for all the varieties of action is **purgative**, from Latin *purgo*, I cleanse, since the effect is to clear offensive material from the bowel. **Cathartic** is a term implying the same thing, being derived from the Greek *kathairo*, I purge. When the means used are such as to cause simply a movement of the bowel in the mildest possible way, without producing any marked effect upon secretions or the walls of the bowel, they are said to be **aperient**, from Latin *aperio*, I open, or **laxative**, from *laxo*, I loose. When the action produced is violent, the substance is said to be a **drastic purgative**, from the Greek *drastikos*, active. Now, ordinarily, purgatives act in more ways than one, they both stimulate the walls of the bowel to increased movement and they excite an increased secretion. But there are others which act specially in one direction. For example, substances like common salt, Epsom salts, rochelle salts, &c., all saline medicines, are particularly active in withdrawing water from the blood and producing copious watery stools, and such remedies are technically called **hydragogue cathartics** (from Greek *hudor*, water, and *ago*, I drive out). Again there are purgatives whose special action consists in increasing the flow of bile from the liver, and these are called **cholagogues** (Greek *chole*, bile, and *ago*); such are podophyllin, rhubarb, calomel, and aloes.

Laxatives or Aperients.

Many substances, not necessarily drugs, act in a mild way in aiding movement of the bowels. Foods which have some roughness when prepared, such as oatmeal porridge and bran bread, are suitable for this purpose. Substances also which have a large residue of undigested material help to a movement of the bowels by their mere bulk, such as vegetables and fruits, like prunes, figs, apples, &c., the vegetable acids of which are also agents in the process.

Castor-oil is the chief of laxative medicines. It is the oil expressed from the seeds of the castor-oil plant — *Ricinus communis* — which grows in America and the East Indies. The remains of the seeds, after the oil has been separated, contain a substance which has a violent purgative action. The castor-oil seeds, or beans, if taken themselves, produce severe inflammation of the bowel, shown by violent vomiting, purging, and collapse, even death. The oil contains almost none of the substance to which these effects are due. It is in small doses mild and non-irritating in action, and is, therefore, suitable for women, delicate persons, and children, and is always a useful agent when it is desired to move the bowels with as little disturbance as possible, as in irritable conditions of the bowel, in pregnancy, when piles or fissure of the anus is present, and in other similar circumstances. When taken by a nursing mother, it acts also upon the child through the milk.

In two opposite conditions it is specially valuable: first in that of simple constipation, where one desires simply to empty the bowel, and to produce no other effects, and second in diarrhœa. The type of diarrhœa in which it is specially useful is that dependent upon some irritating material in the bowel, ill-digested food, for example. The castor-oil sweeps out the offending material, and thus allows the bowel to quiet down. In the diarrhœa of children, therefore, in particular that dependent upon some error in diet, specially apt to occur in summer, is castor-oil valuable.

Dose for adults, $\frac{1}{2}$ to 1 ounce.
,, children, 1 tea-spoonful and upwards.

For constipation it is best given in the morning, an hour before breakfast; given thus early, a small dose often suffices. From 15 drops to half a tea-spoonful may be tried. The spoon or glass in which it is to be dropped should be well wetted with water or peppermint water. Indeed, if a little peppermint water be taken in the vessel first, and the oil dropped upon it, the glass being kept in gentle motion to keep the sides wet and free from the oil, the oil may be swallowed down floating on the water, and leaving no taste. Lemon-juice, coffee, and milk are used on which to float the dose, or an equal quantity of glycerine may be added to the dose, and a drop or two of oil of cinnamon. Castor-oil is recommended to relieve painter's or lead colic. In threatened inflammation of windpipe and in bronchitis a dose affords much relief. It may be dropped into the eye to relieve the feeling of sand in the eye, and in cases of accidental burning of the eye. The leaves of the castor-oil plant have been used as a poultice to the breast to encourage the flow of milk.

Senna is also a much-used laxative medicine. It is the leaves of small shrubs belonging to the genus *Cassia*. There are several kinds, one Egyptian—Alexandrian senna, another Indian—Tinnevelly senna.

The preparations of senna are as follows:—

Infusion of Senna,	Dose, 2 to 4 table-spoonfuls.
(Senna leaves 1 oz., sliced ginger 30 grs., boiling water 10 ozs.; infuse one hour and strain.)	
Syrup of Senna,	,, $\frac{1}{2}$ to 4 tea-spoonfuls.
Confection of Senna contains, besides senna in powder, coriander, figs, tamarind, cassia pulp, prunes, extract of liquorice,	,, 60 to 120 grains.
Tincture of Senna,	,, 1 to 4 tea-spoonfuls.
Black Draught, or Compound Mixture of Senna,	,, 2 to 3 table-spoonfuls.
(Epsom salts 4 ozs., extract of liquorice $\frac{1}{2}$ oz., tincture of senna, $2\frac{1}{2}$ ozs., compound tincture of cardamoms $1\frac{1}{4}$ oz., infusion of senna enough to make up a pint.)	
Compound Liquorice Powder, made of 1 oz. powdered liquorice root, 1 oz. of senna, and 3 ozs. of sugar,	,, 30 to 60 grains.

Senna acts briskly on the bowel, increasing both the movement and the secretion from the walls of the bowel. It acts chiefly on the small intestine, and not on the large intestine. This contrasts it with aloes, which acts principally on the large bowel. It is apt to cause sickness and griping, but this is avoided by combining it with other drugs, such as Epsom salts, and as illustrated in the compound senna mixture. Senna taken by a nursing mother will affect the child. It should not be given when any irritability of bowel is present. The syrup is a pleasant opening medicine for children; and the compound liquorice powder is very largely used for simple constipation.

Sulphur also belongs to the laxative group of medicines, because of its stimulating effects on the wall of the bowel. The preparations and other uses of sulphur and its compounds are stated at length on p. 826. For the laxative effect the old-fashioned sulphur electuary is the best form for administration.

Tamarind.—The preserved pulp of the fruit of the Indian tamarind is a pleasant and effective medicine. The *Tamarindus indica* is a tree 60 to 80 feet high, indigenous to India and tropical Africa, belonging to the natural order Leguminosæ, the same order as the pea and bean. The fruit is a pod about 6 inches long and 1 inch broad, containing an acid pulp, in which the seeds, nine to ten in each pod, are embedded. The West Indian fruit is shorter in pod. The pod is inclosed within a thin pale-brown shell, which is removed for purposes of preservation, and then the soft pods are pressed into a mass, to which sugar is sometimes added. In Upper Egypt the soft pulpy mass is formed into cakes, and dried in the sun; in the West Indies hot syrup is poured over the pods. From the fresh leaves and flowers of the tamarind cooling acid drinks are prepared.

Tamarinds contain citric, tartaric, and malic acids to the extent of over 10 per cent, also cream of tartar is present to the extent of $3\frac{1}{4}$ per cent, and nearly 24 per cent of sugar, gum, and pectin. Woody fibre forms over 34 per cent, and water $27\frac{1}{2}$ per cent.

Purified tamarind pulp is prepared by making a semi-liquid mass of East Indian tamarinds with boiling water, passing the whole through a hair sieve, and then evaporating the fine pulp obtained to a proper thickness and adding a fifth of its bulk of powdered sugar. The prepared pulp is employed in the making of confection of senna.

Tamar Indien is a kind of laxative sweetmeat. It consists of compressed tablets of tamarind pulp to which some purgative has been added, perhaps senna or jalap, and which is flavoured with other materials.

The quantity of tamarinds necessary for laxative effect is ¼ oz.

Besides being laxative, tamarind, because of the acids and cream of tartar it contains, is useful for diminishing thirst, is cooling, and useful in feverish conditions. For drinking purposes **tamarind whey** is the form of employment. It is prepared by boiling 1 oz. of tamarind pulp with a pint of milk and then straining and filtering, and a simpler drink may be made by adding 4 ozs. of tamarinds to 100 ozs. of boiling water, straining, filtering, and allowing to cool.

Buckthorn is another mild opening medicine in common use as a syrup. The buckthorn is a branching shrub about 9 feet high, growing in thickets in Europe and Siberia, native to Britain, and cultivated to some extent for hedges in North America. It belongs to the natural order Rhamnaceæ. There are several allied plants employed as laxatives in medicine, all of which may be noted here. The **common buckthorn** is *Rhamnus catharticus.* The ripe berries are employed to yield a juice—Buckthorn juice, which is used only in the manufacture of the syrup of buckthorn. There is the **alder buckthorn** or black alder, a shrub 10 to 15 feet high, the proper name of which is *Rhamnus Frangula.* The dried bark, frangula bark, is employed as a domestic purgative in Germany. A decoction of it is prepared with ½ oz. of bark and ½ pint of water and given in table-spoonful doses. There is a recognized extract of frangula bark and a liquid extract. The bark should be kept at least a year before being used; when it is fresh it has too irritating properties.

A third kind of allied plant is the *Rhamnus Purshiana* found on the Pacific slopes of North America. It is a small tree, 15 to 20 feet high. The bark is used to yield an extract. On the Pacific coast it is called **Chittem-bark**, and is now more commonly known as **Cascara Sagrada**, or sacred bark.

The commonly used preparations of these varieties of the buckthorn species are as follows:—

	DOSE.
Syrup of Buckthorn, ...	½ to 4 tea-spoonfuls.
Fluid Extract of Frangula Bark,	1 tea-spoonful.
Extract of Frangula Bark,.....	15 to 60 grains.
Liquid Extract of Cascara Sagrada,..................	10 to 60 drops.

Uses.—Syrup of buckthorn is much used as a domestic remedy for children. It acts quickly but is apt to be accompanied with some griping. The liquid extract of cascara sagrada is, however, very extensively used in cases of habitual constipation, not as a purgative, but simply to secure no more than a natural motion. For this purpose the person troubled with habitual constipation should find the dose that is just sufficient to secure an ordinary motion. He should begin with 30 drops, which may be taken flavoured in any way he pleases. If that is not enough, a tea-spoonful may be tried; if it on the contrary acts too strongly, 15 drops may be sufficient. But let the exact quantity be determined, and then let that quantity be taken regularly once a day, at bed-time or on rising in the morning. A smaller dose is likely to be sufficient, if taken in the morning on an empty stomach, but some people prefer to take the medicine at bed-time, and it is then likely to act after breakfast, and so inconvenience during the day is avoided. After taking the drug regularly in this way, each day for a fortnight or three weeks securing a regular motion, the effort may now be made to diminish the medicine. It is still to be taken daily with perfect regularity but in gradually diminishing doses. Thus, if 15 drops have proved sufficient, 14 drops may be taken. If it is still sufficient, after several days 13 drops may be used, and so on. For with habitual use of cascara sagrada, unlike ordinary purgative medicine, a tonic effect on the bowel is produced, and smaller doses begin to have the required influence. In time the constipation may thus be completely relieved, and the use of medicine discontinued.

Dandelion Root.—The fresh and dried roots of *Taraxacum Dens Leonis* gathered between September and February from meadows and pastures in Britain. Its preparations are:—

Decoction of Dandelion,	Dose,	2 to 4 ounces.
Extract of Dandelion, ..	,,	5 to 15 grains.
Dandelion Juice, ...	,,	2 to 4 tea-spoonfuls.

Uses.—Dandelion was believed to stimulate the flow of bile directly. It appears, however, that it promotes the flow of bile only by its slightly opening effect, and that its chief value is as a tonic and mild laxative. It may be given in cases of habitual constipation and weak digestion, and is usefully combined with the dilute nitro-hydrochloric acid when liver symptoms are prominent. It sometimes acts upon the kidneys.

Other drugs used as laxatives are:—

Glycerine in a dose of 1 to 2 tea-spoonfuls.
Light and Heavy and Carbonate of Magnesia (see p. 843).
Manna (see p. 590).
Olive-oil,......... Dose, 1 to 2 tea-spoonfuls.
Almond-oil,..... ,, ,, ,,

Simple Purgatives.

These are substances which act more strongly than the mere aperients or laxatives, owing to a more pronouncedly irritating effect upon the walls of the bowel. On this account they are likely to be attended with some amount of griping, and they produce more liquid stools, acting, it may be, more than once. Some of the drugs already named under the laxatives act as simple purgatives if given in larger doses, such as senna, buckthorn, and castor-oil. The chief of the simple purgatives are rhubarb and aloes.

Rhubarb is the dried root of a plant obtained in China, Chinese Tartary and Thibet, and imported from Shanghai and Canton. It was known as a purgative in China from time immemorial, the earliest accounts of it coming through Arabian writers. Its name is derived from that of the river Rhâ—the Volga—from which direction it came to the countries bordering the Levant. Its chief preparations are as follows:—

	DOSE.
Tincture of Rhubarb,..........	1 to 8 tea-spoonfuls.
Wine of Rhubarb,................	1 to 2 ,,
Syrup of Rhubarb,................	1 to 4 ,,
Powdered Rhubarb Root,.......	10 to 30 grains.
Gregory's Powder (Compound Rhubarb Powder),.. (Powdered rhubarb root 2 ozs., light magnesia 6 ozs., ginger 1 oz.)	30 to 60 ,,
Compound Rhubarb Pill,.... (Contains rhubarb, aloes, myrrh, hard soap, oil of peppermint, and treacle.)	1 to 2 pills, 5 grains in each.

Uses.—The stimulating effect of rhubarb is experienced if a piece of the root be chewed in the mouth; it promotes the flow of saliva owing to the bitter principle it contains. It has a similar effect on the stomach, if taken in a small dose, acting, therefore, as a slight tonic to the stomach. Rhubarb contains a form of tannic acid, and, therefore, in small doses a slight astringent effect is produced. By larger doses the bowel movement is much increased, and a purgative action results, the flow of bile being also increased. After the contents of the bowel have thus been expelled, the tannic acid comes into play, and a binding effect is produced. Rhubarb is therefore, a very popular and useful remedy in cases of diarrhœa, due to the presence of some irritating material in the bowel, especially in children, for its first effect is to expel the irritant, and its later effect is to restrain the diarrhœa. For children it is commonly and rightly associated with magnesia for this purpose. The presence of piles is another condition in which rhubarb is useful, since it not only opens the bowels but exercises a tonic influence on the lining membrane of the bowel.

The doses named above are chiefly purgative doses. If tonic and astringent effects only are desired, less quantities, about half those named, would be employed.

Aloes is the dried juice of several varieties of the Aloe, belonging to the lily order of plants. There is the Socotrine aloes, derived from plants grown chiefly in Socotra and imported by way of Bombay, the Barbadoes aloes from the *Aloe vulgaris*, and Cape aloes.

Its preparations are as follows:—

	DOSE.
Barbadoes or other kind of Aloes in powder,..............................	2 to 6 grains.
Tincture of Aloes (from Socotrine Aloe), ...	1 to 2 tea-spoonfuls.
Wine of Aloes ,, ,, ...	1 to 2 ,,
Compound Decoction of Socotrine Aloes, ...	2 tea-spoonfuls to 4 table-spoonfuls.
Extract of Aloes (from Socotrine Aloe),..................................	1 to 3 grains.
Extract of Aloes (from Barbadoes Aloe), ...	½ to 2 ,,
Pill of Aloes (both kinds of Aloe), ...	1 to 2 pills of 5 grains each.
Pill of Aloes and Iron contains Barbadoes aloes, sulphate of iron, with compound cinnamon powder and confection of roses,........	
Pill of Aloes and Myrrh contains Socotrine aloes, myrrh, saffron, and confection of roses,........................	
Pill of Aloes and Assafœtida contains Socotrine aloes, assafœtida, hard soap, and confection of roses,................	
Aloin,..	¼ to 2 grains.

Uses.—All varieties of aloes contain a bitter principle, **aloin**, which can be separated out in small colourless needle-shaped crystals, to which the effects of the aloes are due. Its chief effect is to stimulate the movements specially of the lower end of the large bowel. Influencing mainly the termination of the bowel, its action is slow, so that it produces no effect for ten, fifteen, or even twenty-four hours after its administration, when it produces a large soft stool, with little griping, unless a large dose has been given, when pain and severe straining and even bleeding from the bowel may result. If it is given in large doses, the great irritation produced is not confined to the lower end of the bowel but affects neighbouring organs, and specially in women the womb. It stimulates also the secretion of the intestinal fluid, and it stimulates the liver, increasing the flow of bile. Indeed the presence of bile is necessary for its purgative action, and consequently in cases of illness, where there is absence of bile, if aloes is to be administered it is combined with purified ox-gall. These facts indicate very clearly the conditions in which aloes is a desirable purgative to employ, and also under what circumstances one ought to be chary of giving it.

If habitual constipation seems to be the result of weakness of the large bowel, the motions accumulating in the rectum, it is the proper purgative to use, *provided piles or other irritable condition does not exist.* It is improper to give it to women during pregnancy, from the risk of the irritation leading to abortion. But this very reason is one which indicates its usefulness in certain conditions of the womb associated with constipation. In absence of the monthly discharge it is given, combined with iron or myrrh, about the time the illness is expected, in order to stimulate its occurrence. One advantage of aloes in habitual constipation is that its use does not tend to make the constipation all the worse after its action. Increasing doses are not required as with most other purgatives, but rather the reverse. Owing to its slowness of action it is well to give aloes as a dinner pill, that is just before dinner, and it may then be expected to act next morning after breakfast. The most useful form of administration is aloin, given in pill in combination with other drugs to check any griping action. An excellent pill of this description is prepared by Schieffelin, of New York, of aloin, belladonna and strychnine, and to be had in the larger towns all over the world. They are very small and tasteless, but effective. The compound decoction is an excellent preparation, and useful in the constipation of children, when the motions are very hard, and accompanied by general digestive derangement.

Stronger Purgatives or Cathartics.

Cathartics, as already explained, are drugs which purge, but the term is usually applied to those which act more markedly than the simple purgatives already named. This they do by specially acting on the glands of the mucous membrane of the bowel, increasing the amount of fluid poured out, and producing watery stools. At the same time they also excite increased peristaltic movement of the bowel, and thus promote rapid expulsion of the contents. The chief of these are colocynth, scammony, and jalap.

Colocynth, as used in medicine, is the dried fruit, freed from rind and seed, the pulp, that is to say, of the *Citrullus colocynthis*, belonging to the cucumber order, and imported from Smyrna, Trieste, France, and Spain. Its dose and preparations are:—

Powdered Colocynth	Dose, 2 to 8 grains.
Compound Extract of Colocynth contains colocynth, aloes, scammony, soap, and cardamoms,	,, 3 to 10 ,,
Compound Colocynth Pill (Gregory's Pill) contains colocynth, aloes, scammony, sulphate of potash, and oil of cloves,	,, 1 to 2 pills of 5 grains each.
Compound Colocynth and Henbane (or Hyoscyamus) **Pill** is the same as the compound colocynth pill, with the addition of a little extract of hyoscyamus to diminish pain and griping,	,, 1 to 2 ,, ,,

Uses.—Colocynth acts as a strong stimulant to the stomach and bowel, and after large doses the action becomes powerfully irritant, large quantities of fluid being poured into the bowel; in short, a catarrh is produced, just as irritation of the nostrils will cause a flow from them. At the same time the movement of the bowel is increased, so that griping pains are felt and the contents of the bowel are hurried on to the outlet. It does not matter whether the drug is taken by the mouth, injected up into the bowel, or whether the active principle it contains—**colocynthin**—is injected under the skin, the same results follow. The liver is also stimulated, and an increase in the outflow of bile excited. In large doses it acts as a drastic purgative, and would occasion in too large doses inflammatory symptoms. It is a useful medicine in obstinate constipation given with other drugs to aid or correct its action, such as in the compound pill. The compound pill with henbane is more agreeable, because the latter drug diminishes the griping tendency. The purgative action is followed, however, by constipation, and this is a disadvantage. It is, nevertheless, a very useful pill for stout, full-blooded people, on any threat of excess of blood to the head, and in any case where quick relief to the liver and bowels is desired; but it ought not to be given to delicate persons, or any subject to bowel irritation.

Scammony is a plant belonging to the convolvulus order—*Convolvulus scammonia*—growing in Syria and Asia Minor. The dried root is used in medicine. From the fresh root a milky juice is obtained by cutting. This is mixed with juice scraped from the root, and is dried, forming the scammony of commerce. From this the pure resin of scammony is obtained by solution with spirit and precipitation in water.

Powdered Scammony,	Dose, 5 to 10 grains.
Resin of Scammony,	,, 3 to 8 ,,
Confection of Scammony,	,, 10 to 30 ,,
Compound Powder of Scammony, (Scammony powder 4 ozs., jalap 3 ozs., ginger 1 oz.)	,, 10 to 20 ,,
Scammony Mixture, (4 grains resin of scammony rubbed up with 2 ozs. fresh milk.)	,, $\frac{1}{2}$ to 1 ounce for a child.
Compound Scammony Pill contains resin of scammony and of jalap, curd soap, and tincture of ginger,	,, 1 to 3 pills of 5 grains each.

Scammony is contained in the compound colocynth pills.

Uses.—This drug is a powerful purgative, owing to the presence of a substance called **jalapin**, promoting the expulsion of large watery stools, and increasing the flow of bile from the liver. It is not a reliable drug when given alone. It has no marked taste, and has, therefore, been used for children in the form of scammony mixture. It is used not only for constipation, but to expel tapeworm, but ought not to be used for delicate children.

Jalap is the dried tubercles from the root of a plant, the *Exogonium Purga*, found in the woods of the Mexican Andes. It is also cultivated in the Indian Nilgherry Mountains. The root is reduced to powder. From the root a resin is obtained by means of spirit. The chief preparations are as follows:—

	DOSE.
Powdered Jalap,	10 to 30 grains.
Resin of Jalap,	2 to 5 ,,
Tincture of Jalap,	$\frac{1}{2}$ to 2 tea-spoonfuls.
Compound Powder of Jalap contains powdered jalap 5 ozs., cream of tartar 9 ozs., ginger 1 oz.,	20 to 60 grains.

Uses.—Jalap and scammony resemble one another in containing an active principle, which is similar in both. That of jalap is called **convolvulin**, that of scammony **jalapin**. Jalap is less irritating and less likely to gripe. It increases slightly the flow of bile from the liver, but produces a most copious flow of watery fluid from the intestinal glands. It is because of this marked property of removing water that it is used in dropsies. The compound powder is the best for this purpose, owing to the presence of the cream of tartar, and when it is desired quickly to unload the liver, as in cases of congestion of the brain, it is combined with calomel, 5 grains of the latter and 15 or more of jalap, a grain or two of ginger being added to diminish pain. It will thus act in a couple of hours.

Drastic Purgatives.

Drastic purgatives are drugs which excite violent action of the bowels, producing a copious flow of fluid by irritation and increased activity of the bowel walls, the irritation passing into inflammatory action if the doses be large. Some of the drugs already considered act thus if given in excessive doses, such as colocynth, scammony, and jalap; and podophyllin, to be considered under drugs which promote the flow of bile, acts similarly if given freely enough. Such drugs are only employed either when it is necessary, even at the risk of great irritation of the bowels, to withdraw blood quickly from the head, as in threatened congestion or apoplexy, or when one seeks to remove dropsical fluid. They are too harsh remedies to be employed except by skilled persons, and then with great caution.

Elaterium is the most violent of drastic purgatives. It is the sediment from the juice of the ripe fruit of a plant belonging to the cucumber order, the *ecbalium* or *squirting cucumber*. Its dose is $\frac{1}{16}$th grain. A compound powder is made of 1 grain of elaterium and 9 of sugar of milk, of which the dose is $\frac{1}{2}$ to 5 grains. The active principle of elaterium is elaterin, of which even $\frac{1}{40}$th grain is effectual.

Use.—Elaterium is employed to produce frequent watery motions, specially in cases of dropsy dependent upon heart-disease.

Croton-oil, Tiglium-oil, is another drastic purgative. It is an oil expressed from the seeds of *Croton Tiglium*, of the natural order Euphorbiaceæ, found in some of the East Indian and Philippine Islands. It has been used from time immemorial in Hindostan as a purgative, though only introduced into Europe in 1820. Its dose is ⅓d to 1 drop mixed with olive oil, or made into a pill with bread crumbs. A liniment is made with oil of cajuput.

Uses.—Croton-oil is a powerful irritant, whether applied externally or taken internally. It is employed as a liniment to produce inflammation of the skin and the formation of pustules, as one might use a blister, for the sake of reducing inflammation in deeper structures. It used to be employed over joints in cases of inflammation, and on the chest in cases of lung affection, but is not now much employed. The pustules produced are slow to heal and leave unsightly scars. Internally, its irritating effects are experienced as a burning sensation in the throat and stomach, as sickness, perhaps, and speedy purging. Several motions follow the first, more liquid than it. It is seldom resorted to, even in obstinate constipation; but its speedy action—it purges in 1 or 2 hours—is sometimes sought in cases of apoplexy, shock, unconsciousness, where one desires to withdraw blood from the head, and where, because of its small dose, it can be easily administered even to an unconscious person. The dose is simply placed on the back of the tongue.

Gamboge, gum resin obtained from a tree indigenous to Siam, the *Garcinia Morella*. It is a drastic purgative, acting like colocynth, producing watery stools, but is never used alone, and seldom, indeed, at all. A compound pill contains aloes along with gamboge. It will expel worms from the intestine. Its dose is 1 to 4 grains.

Saline Purgatives.

To this class of purgative medicines belong the most commonly used medicines—Epsom salts, seidlitz powder, Rochelle salts, cream of tartar, &c. The chief cause of their purgative action seems to be dependent upon physical laws. On p. 134 the physical process called osmosis has been described. If two fluids containing some salts in solution be separated from one another by an organic membrane, an interchange will occur between the two fluids through the membrane until the fluid on both sides of the membrane come to be alike in the quantities of salts they have in solution. If, for example, on one side of the membrane is water containing much common salt in solution and the fluid on the other side contains less, water will pass through the membrane to dilute the strong solution. If a liquid be swallowed, then in the stomach there is a state of things such as has been suggested. In the stomach is a liquid; flowing in the blood-vessels of the walls of the stomach is another liquid, the blood; these two fluids are separated by an animal membrane, the walls of the blood-vessels; if the two fluids differ from one another in density then an exchange will occur between the blood and the contents of the stomach. Suppose pure spring water has been drunk. It will speedily pass into the blood, diluting it, and the water will then be separated out by the kidney. If the water contain a large quantity of dissolved salts, then water will pass from the blood into the stomach to dilute it, and the bowel will contain a large quantity of fluid material. This is at least a large portion of the mode of action of these saline substances. Doubtless they not only drain water from the blood by this physical process, but also excite the glands, and to some extent increase the movement of the bowel. Sometimes, however, the saline medicine produces little increase of the wave-like movement of the bowel. This explains what sometimes occurs after taking a seidlitz powder. The person feels oppressed with the quantity drank, and the feeling of loaded bowels increases rather than diminishes, but no purging occurs. The powder has acted as explained, and a large quantity of liquid accumulates in the bowel, but for want of stimulus to the wave-like motion of the bowel—peristaltic movement—the fluid is not swept onward. It is gradually reabsorbed and passed back into the blood, and no motion results. To avoid this it is well to combine some simple purgative with the saline draught. Thus a purgative pill is taken at night and a seidlitz powder in the morning; that is to say, when it is about time for the pill to produce increased action of the bowel the seidlitz powder causes a flow of fluid to the bowel, which is then swept onward. The old black draught—syrup of senna and a solution of Epsom salts—is an illustration of the same thing.

Epsom Salts are the sulphate of magnesia. They produce watery stools, but excite the movement of the bowel very little, and may be usefully combined with senna or cascara sagrada (see p. 858). To secure by a single dose purgative action, ½ to 1½ ounces are needful; if taken in repeated doses, 1 to 2 tea-spoonfuls are sufficient each time. About a third of a tea-spoonful in water will act upon the kidneys rather than the bowels if the skin be cool, but will help to cause sweating if the skin be kept warm. A full dose is very useful in feverish conditions, and repeated small doses are advised for biliousness. The early morning is the best time for taking this as well as other saline medicines.

Cream of Tartar, the acid tartrate of potash, has already been mentioned in considering the potash salts (p. 818). If given in doses of from 2 to 8 tea-spoonfuls it acts as a purgative, copious watery stools resulting; if given in doses of from ⅓ to 1 tea-spoonful it acts upon the kidney, increasing the quantity of urine; or, if the body be kept warm, upon the skin, increasing the sweat. Thus an excellent cooling drink—the imperial drink—is made with 1 or 1½ tea-spoonful of cream of tartar, a little sugar, 1 pint of boiling water, and half the peel of a fresh lemon. When used as a purgative it is in combination with jalap or scammony, and usually to remove dropsical fluid.

The tartrate of potash (dose: ¼ to ½ oz.) and the sulphate of potash (dose: 15 to 60 grains) are also used as purgatives, and the general remarks already made at the head of this paragraph apply to them.

Rochelle Salts are the tartrate of soda and potash or tartarated soda. They act like other saline purgatives, but excite the peristaltic movement of the bowel more than Epsom salts. In ¼ to ½ ounce doses this is their effect; in small doses, ½ to 1 tea-spoonful, they increase the flow of water from the kidney.

Seidlitz Powder is a mixture of Rochelle salts and bicarbonate of soda in fine powder, 120 grains of the former and 40 grains of the latter. It is employed for such purposes as have been mentioned in speaking of Epsom salts. It is commonly employed as an effervescing drink. To produce the effervescence the addition of tartaric acid in fine powder to the seidlitz powder, when dissolved in water, is necessary. The seidlitz powders of the shops, therefore, contain the seidlitz mixture in one paper, and in a second paper 37 grains of powdered tartaric acid. The double-strong seidlitz powder contains, in the paper holding the seidlitz mixture, an additional quantity of Rochelle salts to the amount of 160 grains.

Glauber's Salt is the sulphate of soda, of which the dose is from ¼ to 1 oz. It purges by increasing the flow of watery fluid, but also excites the movements of the stomach and bowels. It is a constituent of Carlsbad, Friedrichshall, Hunyadi Janos, and Bilin mineral waters. It is specially useful in cases of torpid liver and habitual constipation, and in ulceration and dilatation of the stomach, and should be taken in the morning. It is best taken in the form of the crystallized Carlsbad salts, of which ⅓ tea-spoonful should be taken in a large tumblerful of warm water immediately on rising.

Phosphate of Soda is a useful purgative for children, as it has little taste and acts gently. It is given in milk or food to the amount of from 3 to 10 grains, and its use is indicated by the occurrence of green or white stools. For adults the dose is ¼ to 1 ounce.

The Fruit Salts which, on the initiation of Eno, have become so widely used, are combinations of Epsom salts, bicarbonate of soda, tartaric acid, white sugar, or similar preparations. As mild purgatives they are very useful, and may be used as cooling and refreshing drinks.

Purgatives which Increase the Flow of Bile.

It has been noted regarding several of the drugs already mentioned that they stimulate the liver and promote the secretion of bile, notably rhubarb, aloes, colocynth, scammony, jalap. Phosphate of soda, Glauber's salt, Rochelle salts, and other substances have also a similar, though less marked, effect. In the meantime, however, we need to notice here only a few purgative drugs which markedly affect the outpour of bile from the liver, leaving to another place (p. 874) to notice other medicines which stimulate the liver without acting as purgatives. The drugs to be noted are podophyllin, euonymin, and iridin, &c. Calomel and other mercurial preparations, such as grey powder, blue pill, &c., have held long a high reputation for acting on the liver. It would appear that they do not stimulate the liver nearly to such an extent as podophyllin and other drugs. What they do accomplish, however, is a thorough sweeping of the bowel of its contents. How this acts in relieving the liver can be briefly explained. When the bile is poured into the bowel, just at the commencement of its course, it is mixed with the food, aiding its digestion and absorption into the circulation. Much of the bile is reabsorbed along with the nutritive portion of the food, and is passed back into the liver, and only a fraction of it is ultimately expelled from the bowel in the motion. The slower the movement of the food along the bowel the greater will be the amount of reabsorption, and the less bile will be expelled from the body. On the other hand, anything which quickens the intestinal movement, anything which hurries the food along the bowel to the outlet, will secure the expulsion of a greater quantity of bile from the body by permitting less time for its reabsorption. It is in virtue of this action that calomel and other drugs have gained their repute for biliousness, relieving the liver, and so on. They so stimulate the bowel movements that the bile poured into the bowel is hurried along with the food, and appears in the loose motions, no time being allowed for its being picked up and passed back to the liver. Thus the bowels are cleared out, the liver is prevented receiving back much material it otherwise would have had returned to it, water is drained from blood-vessels supplying the liver, and that organ is at once greatly relieved and also stimulated, because the liver cells are excited to produce more bile to make up for that which has been lost by the action of the medicine. This explanation will also make it clear how prolonged constipation occasions such a feeling of weight, languor, drowsiness, headache, and produces a sallow dirty complexion. People say this is biliousness, but the biliousness is the effect, not the cause. The sluggish state of the bowel permits the motions to remain long before expulsion, allows time for reabsorption of much of the bile, and the liver is oppressed, not because it itself is to blame, but because an outlet is denied to the bile it produces, which is always being returned to it. Under these circumstances, any medicine which will open the bowel and will quickly sweep out its contents will afford immediate and great relief, even although the liver is only indirectly and but slightly stimulated. To this extent, then, every medicine which acts as a brisk purgative will stimulate or at least relieve the liver, by causing a greater quantity of bile than usual to be expelled altogether from the body. The drugs we have now to consider act directly upon the liver cells, creating an increased *production* of bile by their stimulating effects upon the liver substance, while they also excite the bowel to its speedy expulsion.

Podophyllum is the dried root-stock and rootlets of the *Podophyllum peltatum*, or American **May Apple**, called also **Mandrake** in the United States, where it grows plentifully in rich woodlands. It belongs to the order Berberidaceæ. From this a resin is obtained by means of rectified spirit, called resin of podophyllum or podophyllin.

	DOSE.
Powdered Podophyllum, ...	10 to 20 grains.
Podophyllin (the resin),...........	$\frac{1}{8}$ to 1 grain.
Tincture of Podophyllin, ...	15 to 60 drops.

Uses.—Podophyllin is a powerful purgative, increasing the secretion from the bowel and from the liver, and it thus acts even when injected into the blood. Thus also the resin applied to an ulcer or open wound will produce similar effects along with sickness. It is irritating even to the sound skin, and very irritating to the delicate membrane of eyes, nose, throat, &c., as experienced by workmen engaged in pounding the root. It is a powerful stimulant of the liver, and is particularly useful in the treatment of torpor of the liver, such as is so frequent in persons of a full habit, who live well, and take insufficient exercise, and in cases of bilious headache. Its action upon the bowel, though marked, is, in moderate doses, not very rapid. Its dose can be so regulated that only a single gentle but full motion occurs, but if larger doses be given it purges several times, the stools being very liquid. It does not tend, after moving the bowels, to induce subsequent constipation, and may therefore be used regularly for a long time for habitual constipation. Its tendency to gripe makes it desirable to combine its action with that of other drugs. A good form of administration is—

Resin of Podophyllin,..............	$\frac{1}{6}$	grain.
Extract of Belladonna, ...	$\frac{1}{5}$	,,
Extract of Hyoscyamus, ...	1	,,
Extract of Nux vomica,...........	$\frac{1}{4}$	,,

Make into 1 pill.

One of these pills may be taken daily either at bed-time or just on rising, and before any food has been taken. It may be employed for children suffering from habitual constipation, and for them a solution of $\frac{3}{4}$ grain of podophyllin in 100 drops of rectified spirit is recommended. Of this solution a child may receive from 2 to 10 drops in a tea-spoonful of syrup.

Euonymin is a comparatively recent addition to the list of drugs which stimulate the secretion of bile, while at the same time acting as a purgative like rhubarb or colocynth. It is the active principle of a bark, the bark of the *Euonymus atropurpureus*, belonging to the natural order Celastraceæ, a shrub 6 to 10 or even 14 feet high, found in shady woods of the northern and middle section of the United States of America, east of the Mississippi. It is also called the Wahoo, spindle-tree, or burning bush. The active principle euonymin is obtained from a concentrated tincture of the bark by precipitating with water.

Euonymin, Best given in pill with 1 grain extract of hyoscyamus.	Dose, ½ to 5 grains.
Tincture of Euonymus (made with 1 oz. of euonymus bark and 4 ozs. rectified spirit),	,, 10 to 40 drops.
Extract of Euonymus,	,, 2 to 5 grains.

Euonymin is given in the same circumstances which indicate the need of podophyllin—bilious headache, sluggish liver, constipation. A decoction may be prepared from the bark itself, 1 oz. of bark to 1 pint hot water, infused for half an hour and strained; of this a wine-glassful is a dose. It is advised to take euonymin at bedtime, and to take a saline purge in the morning, sulphate of soda (see p. 863) being the best.

Iridin is a powdered extractive derived from the rootlets of the blue flag or water-flag, *Iris versicolor*, "common in wet and swampy meadows from Canada southward to Florida, and westward to Minnesota and Arkansas." In the United States the following preparations are used:—

	DOSE.
Extract of Iris,	1 to 5 grains.
Fluid Extract of Iris,	5 to 60 drops.
Iridin,	1 to 5 grains.

It is used in the same circumstances as podophyllin and euonymin, and has similar effects. It may be given in pill like euonymin, with hyoscyamus to prevent griping.

Hydrastis.—Golden Seal, Yellow Root, Yellow Puccoon, Orange Root, Indian Dye, Indian Turmeric, are all names for the same plant, *Hydrastis canadensis*, belonging to the Ranunculus order, indigenous to Canada and the United States. It is used in the following forms:—

	DOSE.
Powdered Root,	10 to 30 grains.
Hydrastin,	½ to 5 grains in pill.
Tincture of Hydrastis,	30 to 60 drops.
Fluid Extract of Hydrastis,	1 to 2 tea-spoonfuls.

Use.—This drug is said not only to be a valuable remedy for habitual constipation dependent upon inaction of the liver, but to be also a good tonic to the stomach, and one of the best remedies for the stomach catarrh consequent upon chronic drinking, and probably the best substitute for alcoholic stimulants when their use has to be abandoned. It is also said to be very useful as a lotion in inflammation of the eyelids, as an injection in discharges from the ear, the genital passages, &c. For such purposes two tea-spoonfuls of the tincture to a pint of water may be employed.

Leptandrin, an active principle obtained from the rootlets of *Leptandra virginica* or Culver's-root, Culver's Physic, Black-root, **Baptisin**, derived from the roots of the *Baptisia tinctoria* or Wild Indigo, **Juglandin**, the powdered extractive from the inner bark of the root of *Juglans cinerea*, or Butternut, **Phytolaccin**, the powdered extractive obtained from *Phytolacca decandra*, or Poke-root—all of the plants being indigenous to the United States—are substances which have effects similar to podophyllin in stimulating the liver and bowels. Their doses are as follows:—

	DOSE.
Leptandrin,	½ to 2 grains in pill.
Fluid Extract of Leptandra,	30 to 60 drops.
Juglandin,	2 to 5 grains in pill.
Extract of Juglans,	20 to 30 grains.
Phytolaccin,	1 to 5 grains in pill.

It may be noted regarding juglandin that allied plants to the *Juglans cinerea*, notably the English walnut (*Juglans regia*) and the black walnut, have also been used for medicinal purposes, decoctions or poultices made from the leaves being popularly used for the treatment of sores, and ulcers of all parts, and discharges of all kinds. The decoction, tincture, and juice of the leaves of Phytolacca have been used for similar purposes, and for various skin eruptions, such as ringworm, itch, and mange in dogs. Phytolacca has also a popular reputation for relieving the pains of rheumatism and procuring sleep. It is used in these cases as a tincture of the root or the berries, or a decoction of the root.

Remarks on the Use of Purgatives.—Opening medicines must never be given without due regard to the age and condition of the person. The young and the aged, as well as those of all ages and both sexes who are delicate, or reduced by disease, ought not to have strong opening medicines. The mildest of laxatives ought to be employed, and that after an endeavour has been made rather to regulate the bowels by proper diet. The simplest aperient is castor-oil, and sulphur and senna are also mild in action. In many such cases an injection is preferable to medicine by the mouth. The saline purgatives may be given, but they ought to be warmed, and probably the best will be found in one of the mineral waters, Hunyadi Janos, Carlsbad, or Friedrichshall. Then again caution ought to be displayed in administering purgative medicines to any suffering from irritable or ulcerated conditions of the bowel, or from piles or fissure of the anus, or in cases of pregnancy, or during the monthly illness. Again, it must be remembered that the frequent use of purgatives rather confirms than diminishes a tendency to constipation, and a drug ought, if possible, to be selected which has not this disadvantage. This is the objection to the use of the commonly employed pills, colocynth, &c. It has been pointed out that this disadvantage is got rid of by the use of cascara sagrada, and is not a feature of aloes or podophyllin. Then an endeavour to note the chief feature of the constipation will aid in selecting the drug. If large, hard, dry motions are passed, the indication is that the remains of the food pass too slowly along the bowel, so that too much fluid is removed from them. This aloes would probably aid, or podophyllin, or rhubarb, or senna in the form of compound liquorice powder, or a morning draught of saline medicine. Very dark coloured stools point to the need of a stimulant to the liver, such as podophyllin. When a thorough clearing out of the bowel is desired to relieve the overloaded system, or as a preliminary to the commencement of some medicinal treatment, the best means is a colocynth and hyoscyamus pill at night, and a double strong seidlitz powder in the morning. This also is suitable in the beginning of any inflammatory illness, of lung for example, but not when the bowel itself is affected. Constipation, along with dulness of spirits, headache, and sallow complexion indicates the need of a purgative which shall also stimulate the liver, such as podophyllin. The drastic purgatives ought not to be employed except when ordered by a medical man.

Remedies for Diarrhœa.

Looseness of the bowels may be due to several causes. It may arise from an excessive irritability of the bowel, which causes its peristaltic movement to be increased by the very smallest stimulus. An illustration of this is given by the kind of diarrhœa which threatens the person as soon as he takes food, or a short time after. The entrance of food so excites the whole bowel that its contents are hurried along with unusual rapidity. The remedies applicable to such a case are those which diminish irritability of the bowel, which soothe the bowel. Of these the most employed are **opium** in some form (see section on Drugs which Act on the Nervous System), **belladonna** (see also section just named), and **hyoscyamus** (also considered in the section noted). A single drop, or three drops, of laudanum taken before sitting down to a meal will frequently check this irritability.

Again, diarrhœa is often due to the presence of irritating material in the food, and the obvious remedy for this is to expel it from the bowel as quickly as possible, when the diarrhœa will cease. Thus, castor-oil, or rhubarb, is often the best remedy, the clearing out of the bowel being followed by an astringent action. A few drops of laudanum (4 or thereby) may be added to the oil or rhubarb. Indeed at the very outset of diarrhœa this treatment should in every case be adopted. Then one starts with the knowledge that the bowel is clear, and, if needful, other medicine can then be given.

Excessive acidity of the food is often a cause of diarrhœa, the high degree of acidity acting as an irritant. The bicarbonate of **soda**, or **potash, magnesia** carbonate, or some preparation of **lime** (see p. 843), will be the appropriate remedy in such a case. In children diarrhœa is very often due to the milk curdling in too large pieces in the stomach. These pieces are annoying to the bowel, as they are too large to be easily digested, and as they pass along the bowel they excite it more and more. The addition to the milk of a pinch of soda, a tea-spoonful or two of fluid magnesia, or a tea-spoonful of lime water, will prevent the too rapid curdling of the milk by the acid juice of the stomach, smaller curds will be formed, easy of digestion, and the diarrhœa will cease. In looseness of this kind the presence of small pieces of white curd in the stools sufficiently shows the nature of the complaint.

These methods of checking diarrhœa are indirect, the cause of the irritation of the bowel is removed, and the flow ceases. But there is a set of drugs which act upon the blood-vessels of the bowel, causing them to contract, diminishing the flow of blood through the mucous membrane of the bowel, and thus diminishing the production of intestinal fluid. In short, the opposite action is sought to that described under purgatives, by which one seeks to *increase* the flow of intestinal fluids. This astringent effect on the blood-vessels of the bowel is accomplished by **acids**, the acids named on p. 841. The **acetate of lead** is also valuable in this way (see p. 836).

There is next a group of substances which act upon the whole tissue of the bowel exposed to their influence, constringing it, and so checking any discharge, whether it be mucus or blood. The chief of these substances are catechu, kino, krameria or rhatany, oak-bark, and they are dependent for their constringing action upon the tannic acid or some variety of it which they contain. The action of tannic acid and gallic acid we shall therefore first consider.

Galls are excrescences on a variety of oak found in Asia Minor, *Quercus infectoria*, due to the punctures and deposit of eggs of an insect, *Cynips gallæ tinctoriæ*. The irritation causes a swelling to occur which surrounds the egg, and within which the insect develops. When the nuts are broken a central cavity is seen in which the insect may be found, or it may have already escaped, in which case a canal will be found bored to the surface. The preparations of galls are:—

Tincture of Galls,......... Dose, ½ to 2 tea-spoonfuls.
Gall Ointment.
Gall and Opium Ointment.

The action of galls is practically the same as that of tannic acid, obtained from it. It is in the form of the gall or gall and opium ointment it is chiefly employed. This is used as a local astringent to the bowel in cases of piles, being simply applied to the part.

Tannic Acid is extracted from powdered galls with ether. It has a very strong astringent taste, and is very easily dissolved in water.

Tannic Acid,........................... Dose, 2 to 10 grains.
Glycerine of Tannic Acid contains 1 of tannin to 5 glycerine, dissolved by aid of heat.
Suppositories of Tannic Acid.
Lozenges of Tannic Acid,........ Dose, 1 to 6 lozenges. (½ grain of acid in each—the American lozenges contain 1 grain in each.)
Styptic Colloid (20 of tannic acid, 5 of alcohol, 20 of ether, 55 of collodion).

Uses.—Tannin coagulates albumin, and, applied to broken skin, causes it to contract by coagulating the fluids of the tissue. The blood-vessels of the part are reduced in size by the contraction of the surrounding tissues, and thus bleeding is arrested, as well as by the clotting of any blood by the influence of the tannin. In contact with the lining membrane of the mouth, gullet, stomach, and bowels, it produces dryness by coagulating the mucus, and the constringing effect produces a sensation of roughness and stiffness, diminishing the flow of blood along the vessels, and in this way, as well as by a direct action, diminishing secretion. These effects indicate in how many ways tannin is useful. It is employed to stop bleeding and discharges in all situations, from nose, throat, skin, bowels, womb, &c. For these purposes the glycerine compound is very well suited. The suppositories are useful in piles and other conditions of the lower end of the bowel. It is given also to arrest bleeding in organs besides the stomach and bowels. Its effect in checking bleeding in the stomach and bowels is readily understood, but it is also believed to check bleeding in other organs, such as the lungs, though given by the mouth. It reaches the blood and distant organs as gallic acid. For such bleeding, therefore, the use of gallic acid itself is to be preferred, since the local effect of tannic acid is not desired. It is seldom given for diarrhœa, and only in extreme cases.

Gallic Acid is prepared from galls by allowing a paste formed of pounded galls to ferment, gallic acid being derived from the splitting up of tannic acid.

Gallic Acid,............... Dose, 2 to 10 grains.
A glycerine and ointment are prepared.

Gallic acid is chiefly used in cases of bleeding from organs which can be reached only through the blood, such as the lungs and kidneys. In bleeding from the lungs, it is given in doses of 10 grains every two hours.

Catechu, as employed in medicine, is an extract of the leaves and young shoots of *Uncaria Gambier*, a shrubby climber indigenous to countries about the Straits of Malacca, and extensively cultivated near Singapore. Its preparations are:—

	DOSE.
Powdered Catechu,.........	10 to 30 grains.
Tincture of Catechu,.....	½ to 2 tea-spoonfuls.
Infusion of Catechu, ...	2 to 4 table-spoonfuls.
(Coarse powder of catechu 160 grains, bruised cinnamon 30 grains, boiling water 10 ounces; infuse half an hour and strain.)	
Compound Powder of Catechu (contains catechu 4, kino 2, rhatany 2, cinnamon 1, nutmeg 1), .	Dose, 15 to 30 grains.
Lozenges of Catechu,...........	,, 1 to 3 lozenges.

Uses.—Catechu is used because of the effect of the tannic acid it contains. It is used as an astringent for the mouth in the case of soft bleeding gums, and for the throat in relaxed conditions, and for hoarseness. In these cases the lozenges are useful, or the infusion may be used as a gargle. It is employed as a lotion for bleeding from the nose, and as an application to cracked nipples. The tincture or infusion is very useful for diarrhœa in children, and is usually employed for adults in combination with a little tincture of opium and chalk mixture.

Black Catechu, Terra Japonica, or Cutch, an extract prepared from the wood of *Acacia Catechu* is to be distinguished from the above, which is pale catechu. Its dose is 5 to 15 grains, and in America a compound tincture and lozenges are made of it.

Kino is the juice obtained from incisions made in the trunk of the kino tree, indigenous to India and Ceylon, called **buja** in Bengal, the technical name being *Pterocarpus Marsupium.* It is imported in the dried state from Malabar. It contains a species of tannin from which it derives its most important qualities. Its preparations are:—

	DOSE.
Powdered Kino,....................	10 to 30 grains.
Compound Powder of Kino (Powdered kino 15, opium 1, powdered cinnamon 4),..	5 to 15 ,,
Tincture of Kino,..................	½ to 2 tea-spoonfuls.

It is useful as a gargle for relaxed throats, the tincture being added to water, and it is employed in diarrhœa, and in the stomach disorder called pyrosis or water-brash. It is milder in action than catechu.

Rhatany is the dried root of *Krameria triandra,* a low shrub native to Bolivia and Peru.

	DOSE.
Powdered Rhatany,............	20 to 60 grains.
Extract of Rhatany,...........	5 to 20 ,,
Infusion of Rhatany (1 oz. in 20 boiling water, infused 1 hour and strained),	2 to 4 table-spoonfuls.
Tincture of Rhatany,..........	1 to 2 tea-spoonfuls.

Uses.—Rhatany is an astringent like the others, and its astringent effects are brought to play upon external affections, such as ulcers, fissure of the anus, cracked nipples, &c., as well as upon diarrhœa and other internal disorder. It is used as an injection in dysentery and for uterine complaints, also as an injection.

Red Gum is an exudation from the bark of *Eucalyptus rostrata,* the red gum-tree, and imported from Australia. Its preparations are:—

	DOSE.
Decoction of Red Gum,.........	2 to 4 tea-spoonfuls.
Liquid Extract of Red Gum,...	30 to 60 drops.
Tincture of Red Gum,...........	20 to 40 ,,
Syrup of Red Gum,...............	30 to 60 ,,
Red Gum Lozenge,...	Each lozenge contains 1 grain.

Use.—Red gum is an excellent remedy for various kinds of relaxed mucous membrane. As the lozenge it is excellent for hoarseness and relaxed throat. Mixed with an equal quantity of starch in fine powder it may be blown into the throat. A tea-spoonful of tincture to 7 of water makes an excellent gargle, and a table-spoonful of the liquid extract to a pint of water forms an astringent injection for the bowels or genital passages, or to inject into the nostril, either to stop mucous discharge or bleeding. The tincture or liquid extract or decoction may be used for diarrhœa or bleeding from the bowel, or dysentery. In these latter cases it is often given with liquid extract of bael fruit.

Bael Fruit is the dried half-ripe fruit of *Aegle Marmelos,* the Indian Bael, or Bengal Quince, belonging to the orange order. The fruit resembles an orange of large size and the juice is gummy and pleasant flavoured. Its preparation is:—

Liquid Extract of Bael,.... Dose, 1 to 2 tea-spoonfuls.

It is extensively used in India, because of its astringent qualities, in the treatment of bowel complaints. In chronic diarrhœa following typhoid fever it has been found singularly efficient, and it is sometimes applied as a wash to the eyes when inflamed. It is frequently given in combination with liquid extract of red gum.

Logwood is sometimes used as an astringent in diarrhœa and dysentery. It is the sliced heart-wood of *Hæmatoxylon campechianum,* native to the shores of the Gulf of Campeachy, and naturalized in many of the West Indian Islands. A decoction and extract are prepared, the dose of the former being 1 to 2 ozs., and of the latter 10 to 35 grains. It colours the urine of those taking it pink. It is a mild astringent, quite suitable for use in checking diarrhœa of infants, to whom it may be given by the mouth or as an injection.

Oak and Elm Bark also contain tannic acid, and decoctions might be used as astringents like catechu, kino, &c. The decoction of oak bark is made of a strength of 1 of the bark to 15 of water, and the dose is 1 to 2 ounces; that of elm bark is 1 in 8, and the dose is 2 to 4 fluid ounces.

Alum, a compound of ammonia and alumina with sulphuric acid, the sulphate of ammonia and alumina, is a very strong astringent. Its preparations are:—

Powdered Alum,................	Dose, 10 to 20 grains.
Dried or Burnt Alum,...	Externally for proud flesh, &c.
Iron Alum,.......................	Dose, 5 to 10 grains.

Use.—Alum has a marked constringing action. The burnt alum, when applied to any raw surface, sears the surface, and is therefore used for "proud flesh," and for foul ulcers. When a weak solution of alum is taken into the mouth, its constringing action on the lining membrane is at once perceived; when it is absorbed into the blood and conveyed to the various tissues it appears to exert a similar effect upon them also. It is, however, used chiefly for its local effect, and not much for effects after absorption into the circulation, though it is sometimes employed for arresting bleeding, as from the lungs, and discharges from various organs. Its local effect is obtained by using it in the form of gargles and washes. Thus a gargle of 60 grains alum, 2 tea-spoonfuls of honey, and 6 ounces of water is very useful for relaxed and inflamed throat, or soft spongy gums; another gargle of 60 grains of alum, ½ tea-spoonful of tincture of myrrh, and 4 ounces of water is useful under similar conditions and in ulcerated conditions of the mouth and throat. For checking bleeding from the mouth, nose, gums, anus, or from leech bites, it may be applied as a dusting powder, or in strong solution (60 grains to the ounce or stronger), upon a sponge or lint. For injection, alum may be used of a strength of 1 tea-spoonful and upwards of the powder to a pint of water, and the iron alum is a valuable preparation for this purpose. These are commonly used injections in discharges from the genital organs in women. A solution of from 1 to 3 grains in an ounce of water is good for inflammation of the eyelids accompanied by matter. Alum may be administered internally in the dose stated above, given in water or syrup or dissolved in white of egg solution, or in the form of alum whey. **Alum whey** is prepared by boiling 120 grains of alum in 1 pint of milk and straining. An ounce of this might be taken at a time. It may be thus administered for bleeding from the kidneys or bowels or for diarrhœa. The diarrhœa of typhoid fever is said to be better treated by alum than by any other astringent except acetate of lead; and in chronic dysentery it is valuable when used occasionally. Alum acts, however, as a purgative if given in large doses (60 grains), doubtless because of its irritant effects, and this quantity, or double, given in treacle or syrup acts as an emetic, draughts of warm water promoting the sickness once retching has commenced.

Iron Preparations are useful as intestinal astringents in diarrhœa and bleeding (see p. 817).

Copper Preparations are also sometimes used for diarrhœa, because of their astringent action on the bowel. The chief compound of copper used as a drug is:—

Sulphate of Copper, ... Dose, ½ to 2 grains.

Verdigris is a subacetate of copper, but is not used in medicine.

Uses.—Copper is very frequently used because of its astringent effects when applied directly to ulcers, wounds, &c., in the form of **blue-stone**. When applied in mass to the broken skin, or sprinkled on as a fine dust, it acts as a caustic, and is used for warts, proud flesh, unhealthy ulcers, and poisoned wounds. It is, however, far too frequently employed in domestic surgery. The "proud flesh," which sprouts from a healing wound, is to the uneducated eye a very undesirable thing, to be "burnt off" time and again, but to the surgeon it is the thing to be desired, as by it the wound is healed. If it becomes "exuberant," as the phrase is, he diminishes that tendency by the well-regulated pressure of a bandage, but probably the skilful surgeon almost never takes a piece of blue-stone between his fingers, unless it is to throw it away, as one has expressed it. When used in solution of 3 or 4 grains to the ounce of water it acts as a stimulant. A solution of 2 to 5 grains to the ounce is occasionally used as an injection, but not frequently, and specially in falling of the bowel and excessive secretion in that neighbourhood. Given in small doses internally, it acts as a tonic and astringent to the stomach and bowels in diarrhœa and dysentery. For such purposes it is often combined with opium, ¼ grain sulphate of copper, ¼ grain gum opium, made into a pill with confection of roses, and given occasionally. Dysentery is often benefited by an injection into the bowel of a pint of tepid water containing 10 to 20 grains of sulphate of copper in solution. Copper in small doses in pill has also been administered as a tonic to the nervous system in St. Vitus' dance and epilepsy. In large doses (2 to 10 grains of the powdered sulphate mixed with powdered sugar or dissolved in 2 ounces of water) copper is very useful as an emetic, especially in cases of laudanum or other narcotic poison. It does not produce nausea or depression and it acts rapidly. It is also used as an emetic in croup and bronchitis to expel material from the air-passages, the absence of depression being in such cases a great advantage. Poisoning by copper is not common, because of its emetic action, unless very large doses, leading to ulceration of bowel, have been taken. It is also employed as an antidote to phosphorus poisoning, 3 grains of the sulphate being given in water every few minutes, till vomiting occurs, after which a seidlitz powder should be administered.

Zinc is employed in cases almost identical with those for which copper may be used, but is much more freely used than the latter. Its preparations in common use are:—

	DOSE.	
Sulphate of Zinc,......	1 to 3 grains	as tonic.
	10 to 30 ,,	as emetic.
Oxide of Zinc,..........	2 to 10 ,,	in pill.
Acetate of Zinc, ...	1 to 2 ,,	as tonic.
	10 to 20 ,,	as emetic.
Valerianate of Zinc, ...	1 to 3 ,,	
Phosphide of Zinc,......	$\frac{1}{16}$ to $\frac{1}{8}$,,	
Zinc Ointment	(80 grains of oxide of zinc to 1 oz. of benzoated lard).	
Oleate of Zinc.		
Chloride of Zinc, ...	For external application only.	

Uses.—Like copper, zinc when used in strength acts locally as a caustic, and when in weaker solution acts as an astringent and tonic. It is of very wide application in the form of lotion and ointment for wounds, sores, ulcers, and inflamed surfaces generally. The chloride of zinc is highly caustic, and is used in solid sticks to destroy tumours, and in strong solution to wash over foul ulcers. In solutions of 2 grains to the ounce it is a valuable tonic and stimulant to sores and wounds of various kinds. The sulphate of zinc in solutions of 1 and 2 grains to the ounce of water is used to bathe wounds, to bathe inflamed and mattering eyelids, and for injections to limit discharges from the womb, &c. It is also a soothing and cooling application to itching diseases of the skin, specially eczema. Zinc ointment is a soothing and healing ointment, and the more recent oleate of zinc is a better application, mixed with lard or vaseline to the amount of 1 part of the former to 3 of the latter. Oxide of zinc dusted very lightly in very fine powder is a soothing dusting powder for surfaces inflamed by rubbing against one another, such as frequently occurs in children. Taken internally, zinc acts as an astringent and tonic in small doses, and an irritant and emetic in large doses. The oxide is given occasionally for diarrhœa, and has been administered in chronic cases of diarrhœa to children with successful results. The sulphate may be given for the same purpose. The oxide, valerianate, and phosphide of zinc are used in nervous diseases, especially those of a convulsive type, such as St. Vitus' dance (chorea), epilepsy, whooping-cough. Two-grain doses three times a day may be given in pill, of the oxide and valerianate, and $\frac{1}{3}$ of a grain of the phosphide. The oxide of zinc is most frequently used to control excessive sweating, and in particular, the night sweats of consumption, for which it may be given in pill of 1 or 2 grains at bed-time. The sulphate and acetate of zinc are most valuable emetics (see p. 851).

Silver Salts have also astringent and tonic properties. The salts chiefly used are:—

Nitrate of Silver,...........	Dose,	$\frac{1}{6}$ to $\frac{1}{3}$ grain.
Oxide of Silver,...............	,,	$\frac{1}{2}$ to 2 grains.

Uses.—Like copper and zinc, silver salts are used externally rather than internally. The solid stick of fused nitrate of silver, commonly called "lunar caustic," is applied to produce superficial destruction of tissue, in the case of chronic ulcers, the result being to stimulate healthy action. Solutions of varying strength (1 to 10 grains to the ounce) are used for like purposes, sore nipples, &c. The solid stick is applied to warts, and a stick is prepared with 1 part of silver nitrate to 2 parts of nitrate of potassium for similar uses, and called **mitigated nitrate of silver.** Internally, nitrate and oxide of silver are used for their tonic and astringent properties in chronic ulceration and inflammation of the stomach, and in chronic diarrhœa and dysentery. For this $\frac{1}{4}$ grain is the dose in pill with bread crumb. In epilepsy and St. Vitus' dance, it is given in similar doses, thrice daily, as a nerve tonic. In all these cases the use of the drug must not be continued beyond 3 or 4 weeks, because of the risk of staining the skin of the whole body brown, a staining which cannot afterwards be removed. If a piece of lunar caustic has been swallowed by accident, a draught of salt and water should be given immediately along with an emetic, for salt forms with it an insoluble substance, chloride of silver. The salt should be given along with gruel drinks or gummy drinks to protect the gullet, when the silver is vomited up.

Remarks on the Use of Remedies for Diarrhœa.—It is a mistake to suppose that on the occurrence of diarrhœa, the immediate thing to be desired is to check the discharge. In a very large number of instances, the looseness is the result of some article of food or drink which is irritating the bowel-walls, and the flux or discharge is the effort of nature to sweep it away. In the first instance, therefore, this effort should be aided, and aided so thoroughly that one may be certain all irritating substances have been swept out. If the diarrhœa still continues, as it may well do, if the irritation has been severe, then one can with confidence administer remedies to soothe the lining membrane, and to check the discharge. The preliminary step, then, is the administration of a full dose of castor-oil, to which a few drops (5) of tincture of opium (laudanum) might be added, or a full dose of rhubarb or senna, or magnesia, or even a full dose of some saline remedy such as seidlitz powder, fruit salt, or the like.

Thereafter, if necessary, a little bismuth (see p. 854) and soda, with or without laudanum (5 to 10 drops), is likely to be all that is necessary. If that is still insufficient some of the stronger astringents may then be given, catechu or kino, with, if needful, laudanum and chalk mixture (see p. 844). In dysenteric conditions of the bowel ipecacuanha is most valuable (see p. 852) either alone or with opium as Dover's powder, and lead and opium, dilute sulphuric acid and opium, tincture of red gum with decoction of bael fruit, and preparations of iron. Injections of starch and opium (see p. 874), decoction of logwood, oak-bark, &c., might be resorted to in extreme cases, but it is only after failure with these that a physician would think of trying the effect of strong astringents like alum, copper, or zinc salts. Throughout the whole treatment care must be exercised in the dieting, broths and soups and beef-teas being avoided, well-boiled arrowroot and milk being the chief food for a day or two, and iced milk, and sips of iced water being given for thirst.

Remedies for Flatulence of the Bowel.

The remedies employed in wind affecting the bowel are the same as those used when the stomach is distended with wind (see p. 849). In addition, it is sometimes possible to cause the wind to be expelled by the use of an injection into the lower bowel. Often flatulence of the bowels will be greatly and quickly relieved by passing the long injection pipe of a syringe several inches up into the bowel, and leaving it there for 15 or 20 minutes; the pipe disconnected from the syringe is meant, and the one used for vaginal injections is best.

Remedies for Worms in the Bowel.

There are two classes of remedies used against intestinal worms: one class belongs to the order of strong purgatives, jalap (p. 861), scammony (p. 861), and gamboge (p. 862). These, simply by their ordinary purgative action, expel worms from the bowel as they expel any other contents. They are, therefore, called **Vermifuges** (Latin *vermis*, a worm; and *fugo*, I drive out). A second class of remedies kill the worms, and require afterwards a purgative to expel them when dead. To this class the term **Vermicide** is applied (Latin *vermis*, and *cædo*, I kill). Both classes are grouped together as **Anthelmintics**, which simply means remedies against worms, without implying whether the remedies destroy the worms or not (Greek *anti*, against, and *elmins*, a worm). The chief drugs destructive to worms—vermicides—are as follows:—

Remedies for Tape-worm (see p. 168).

Male-fern (*Filix mas*).
Areca-nut.
Kamala.
Kousso.
Pomegranate Root.
Turpentine.

Remedies for Round-worms (see p. 173).

Santonica.
Santonin.
Spigelia Root (Carolina Pink).

Remedies for Thread-worms (see p. 174).

Injections into the bowel of common salt, quassia water, lime water, iron, alum, tannin, or substances containing it, such as catechu, kino, rhatany, logwood.

Male-fern.—The parts of the male-fern (*Aspidium Filix mas*) used are the dried root-stock with the bases of the foot-stalk and portions of the root fibres. Its preparations are as follows:—

	DOSE.
Powdered Male-fern Root,...	60 to 180 grains.
Liquid Extract of Male-fern (Oil of Male-fern),..........	30 to 80 drops.
Oleo-resin of Aspidium—(American),..................	10 to 20 ,,

Use.—The male-fern root and preparations are used only for the expulsion of worms, and specially the tape-worm, for which it is the most successful remedy, if given properly. The person should, the day before its use, restrict the amount of food taken, and take chiefly liquids—soups, milk, &c. A dose of purgative medicine ought also to be taken to clear the bowels of all material which would protect the worm from the action of the drug. Next morning ½ to 1 tea-spoonful of the liquid extract is taken in a mixture with 1 or 2 tea-spoonfuls of fresh mucilage and peppermint water or milk to make 2 ounces. An hour later a full dose of castor-oil is taken. If the worm does not come away repeat the treatment.

Areca-nut is the seed of the *Areca Catechu* or betel-nut tree.

Powdered Areca-nut, ... Dose, ½ to ¾ ounce.

Besides being used as an anthelmintic, it is employed as a dentrifice in the form of a paste made of the powder. As an anthelmintic it is to be employed in a way similar to male-fern.

Kamala is a fine orange-red powder consisting of the hairs and glands obtained from the surface of the fruits of *Mallotus philippinensis* (*Rottlera tinctoria*), which grows wild in Australia, Eastern China, India, Southern Arabia, and Abyssinia.

Dose, 30 grains to ¼ ounce.

After taking the powder the worm is usually expelled in a few hours; if not, the dose should be repeated in three hours.

Kousso or Cusso—the female flowers and tops of *Brayera anthelmintica*, a handsome tree of the rose order, native to Abyssinia.

Powdered Kousso,........	Dose, ¼ to ½ ounce.
Infusion of Kousso, ...	,, 4 to 8 ounces.

(¼ oz. kousso in coarse powder, 4 oz. boiling water; infuse in a covered vessel for 15 minutes, and drink when cold without straining.)

For the expulsion of tape-worm by this drug, it should be taken after the patient has fasted for a day. There is an active principle called **kosin** or **coussine**, of which a dose of 20 grains is sufficient, which does not tend to produce the nausea and vomiting sometimes occasioned by the infusion. In America there is a preparation used, the fluid extract of brayera, of which 8 fluid ounces is the dose.

Pomegranate Root Bark is the dried bark of the root of *Punica Granatum*, indigenous to South-western Asia, but now met with in all sub-tropical countries, grown on the shores of the Mediterranean.

Decoction of Pomegranate Root Bark,.........	Dose, 1 to 3 fluid ounces.

(2 ounces of sliced root in 2 pints of water, boiled down to 1 pint and strained.)

The pomegranate root bark is astringent, and requires therefore to be followed by a purgative when used for tape-worm. Several doses are often required; and it is not so active as the male-fern root. It contains two alkaloids, **pelletierine** and **iso-pelletierine.** Of the former there are two compounds, both used for tape-worm.

Sulphate of Pelletierine, ...	Dose, 5 to 8 grains.
Tannate of Pelletierine,....	,, 8 grains.

Five to 8 grains of the sulphate taken fasting, and followed in 15 minutes by a full dose of tincture of jalap (p. 861), causes expulsion of the whole tape-worm in nine cases out of ten. For children of 13 years, half this dose is given, and for infants one-tenth. Of the tannate 8 grains, followed in 2 hours by an ounce of castor-oil, is likely to be effective without colic or headache. Quicker action is obtained if black draught (p. 857) or the compound infusion of senna be used instead of the castor-oil, and the rules as to diet laid down for the employment of male-fern should be followed.

Turpentine is an oleo-resin which exudes from *Pinus australis* and other species of pine, and it occurs in tough yellowish masses. Distilled from this resin is the oil or spirit of turpentine of common use.

Oil of Turpentine,.................. Dose, 5 to 30 drops; as an anthelmintic, ½ to 2 tea-spoonfuls.
Confection of Turpentine,. ...... ,, 1 to 4 tea-spoonfuls; as an anthelmintic, 1 to 2 ounces.
(Oil of turpentine 1 oz., liquorice powder 1 oz., clarified honey 2 ozs.)
Injection of Turpentine.
(Oil of turpentine 1 oz., mucilage of starch 15 ozs., the quantity for one injection.)
Liniment of Turpentine.
(Oil of turpentine 16 ozs., camphor 1 oz., soft soap 2 ozs.; dissolve the camphor in the oil, then add the soap and rub up till thoroughly mixed.)
Acetic Liniment of Turpentine—St. John Long's Liniment.
(Oil of turpentine 1 oz., acetic acid 1 oz., liniment of camphor 1 oz.; mix.)

Uses.—Turpentine when applied to the skin reddens it, producing a burning sensation, and if it be applied on a cloth and kept covered, a blister is produced. It acts, that is to say, as an irritant. Its vapour, when inhaled, similarly irritates the air-passages, causing a feeling of constriction of the chest. Taken internally in small doses, it produces a feeling of heat at the stomach, and in excessive doses acts as an irritant poison, setting up inflammation and ulceration. It is employed externally as a stimulant and counter-irritant in inflammations—applied, for example, to the chest and back in pleurisy, inflammation of the lungs, &c., and to the abdomen in inflammation of the bowel. Poured upon boiling water, a tea-spoonful at a time, it is used as an inhalation in chronic lung affections with discharge. It is used as a liniment for painful joints, neuralgia, sciatica, &c. It is given internally in doses of 10 drops, rubbed up with 30 grains powdered gum acacia and then with 1 ounce of water, in cases of bleeding from ulceration of the bowels in typhoid fever, and it is repeated every 2 hours, watchfulness being exercised lest sickness, vomiting, and symptoms of intoxication arise. It is also valuable in small doses as a stomach stimulant, especially in cases of hysterical flatulence, though its taste and smell render it unpleasant and therefore not much used, and it also expels wind from the bowel, and in larger doses acts as a purgative. Given in the larger doses it is destructive to tape-worm, and is a valuable injection for thread-worms. It must not be forgotten that comparatively small doses are apt to irritate the urinary organs, and produce a feeling of heat and spasm about the urinary organs, difficulty of passing water, and pain in the small of the back.

Santonica is the unexpanded flower-heads of a species of *Artemisia*, imported from Russia, called also Levant worm-seed. The plant belongs to the same order as the daisy—Compositæ. From it **Santonin** is prepared, the active principle of the drug.

Santonica,...	Dose,	10 to 60 grains.	
Santonin,....	,,	1 to 4 ,,	for a child,
		2 to 6 ,,	for an adult.

Santonica and santonin are the best remedies for the round-worm, and are less destructive to the thread-worm. They should be given at night, followed by a brisk purgative on the following morning. A single dose of 2 grains of the latter has sufficed to expel 166 round-worms. It frequently affects sight, causing everything to appear yellowish or greenish yellow, and it colours the urine a bright yellow, giving rise also sometimes in children to inability to retain the urine. If it be given at night, the effect on vision is likely to pass off before morning. Excessive doses cause headache, giddiness, and vomiting, and arrest of the breathing. In cases of poisonous doses having been used, an emetic should be used to empty the stomach, hot stimulants should be administered, and artificial breathing maintained.

Spigelia, Maryland pink or worm-grass, found in shady woods in the southern parts of the United States of America, is employed in America to destroy worms.

Powdered Spigelia Root,...	Dose,	60 to 120 grains.
Fluid Extract of Spigelia, .	,,	1 to 4 tea-spoonfuls.

"The most usual and best form of the medicine is that known as 'worm tea,' namely, ½ ounce spigelia, senna and fennel-seed of each 120 grains, manna 1 ounce, boiling water 1 pint. Infuse. Dose, half a wine-glassful three times a-day for a child two years old." Excessive doses of the drug produce poisonous effects, hot dry skin, nervous excitement of a hysterical kind, pain in the forehead and eyes, stiffness and swelling of the eyelids, squinting, great muscular trembling, &c., and the remedies are wine, ammonia, and other stimulants.

Injections into the Bowel: Enemata: Clysters.

Injections are given for a great variety of purposes. Prepared foods are injected when, owing to some condition of gullet or stomach, foods cannot be administered in the usual way. These are called **nutritive enemata.** Then there are **stimulant enemata.** The most frequent object of an injection into the bowel is to clear out the bowel of its contents, either by mere washing out with water—**simple enemata,** or by the injection of purgative drugs—**purgative enemata.** Injections are also made to restrain bleeding and discharges of other kinds—**astringent enemata,** and soothing drugs may be introduced in the same way—**sedative enemata,** while they may be used against worms—**anthelmintic enemata.** A note of a few of these injections may be given. The injection is administered by means of a syringe (see Plate VIII). The syringe is first washed in hot water to make certain it is in order; then it is carefully emptied, and then filled with the injection material. The tube is then oiled and passed up into the bowel by means of a gentle turning movement, when it should go in quite easily. The injection must be made very slowly and steadily, to avoid irritating the bowel, and causing it at once to expel the whole material.

Beef-tea and Cream Enema.—Mix 4 to 8 ounces of strong beef-tea, an ounce of cream, ½ ounce of brandy, or 1½ ounces of port wine. This may be administered twice or thrice in 24 hours.

Peptonized Enema.—Mix 4 ounces of strong beef-tea with 4 ounces of milk gruel; add half a tea-spoonful of bicarbonate of soda and a dessert-spoonful of liquor pancreaticus (p. 847), and inject.

A Nutritive Enema may be made of any good broth (without vegetable, of course), or beef-tea made gelatinous, or of raw egg beaten up with milk and peptonized (see p. 847). A cupful of milk mixed with 2 tea-spoonfuls of Carnrick's beef peptonoids, with ½ tea-spoonful bicarbonate of soda and a dessert-spoonful of liquor pancreaticus, makes an excellent enema for children, half of this quantity being injected at a time.

Where such injections are used for any time, it is well to clear out the bowel occasionally by a copious injection of warm water. It is desired, of course, that the whole injection should be retained. It is an aid to securing this if the patient lies on the left side, and if after the enema has been given a folded napkin is kept firmly pressed against the outlet of the bowel for a few minutes, till the desire to expel anything has passed away.

Simple Opening Enema.—Inject from a pint upwards of tepid water. This is used for emptying the bowel without further disturbance. It is exceedingly useful for children in convulsions or in fever, or simply for constipation. The bowels can be caused to act almost at once, if a sufficient quantity of water be injected. Even in the case of children a larger quantity than a pint may be used. It is the author's practice to inject as much as possible, *but slowly;* no harm can possibly be done. The result is that soon the bowel can retain it no longer, and everything is swept out almost in one rush. If any hard masses have been lying in the bowel, the large quantity of water, by distending the bowel, separates them from the walls of the canal, and allows of their being swept down.

Soapy Water Enema.—12 ounces of warm water with 1 ounce soap dissolved is somewhat more active than the simple water. About ½ to 1 pint of it may be used.

Salt and Water Enema.—A dessert-spoonful to 2 or 3 table-spoonfuls of common salt are dissolved in 1 or 2 pints of warm water, and slowly injected. This is used when it is desired to act more than once upon the bowel. The action of the salt induces a temporary flux or catarrh of the bowel and recurring motions. It is useful in obstinate constipation and when head symptoms are present, symptoms of congestion of the brain, for example, and the desire is to bring down as much blood as possible from the head to the bowel, and keep it there.

Epsom Salt Enema.—Sulphate of magnesia (Epsom salt) 1 ounce, water 15 ounces. Used for a like purpose to the preceding.

Aloes Enema.—Mix 40 grains powdered aloes with 15 grains carbonate of potash and 10 fluid ounces of a thick solution of boiled starch. The whole of this may be injected when a purge is desired, but only 2 or 3 ounces of it is used to destroy thread-worms.

Assafœtida Enema is a very prompt way of removing wind from the bowels, especially in hysterical people. It is made with 30 grains of assafœtida, rubbed up with 4 ounces of water.

Glycerine Enema.—The injection of a tea-spoonful of glycerine is often sufficient to relieve constipation.

Castor-oil Enema.—Castor-oil 1 ounce, mixed with 12 ounces thick solution of boiled starch. To this 2 tea-spoonfuls of tincture of assafœtida may be added if flatulence exists.

Turpentine Enema.—Of turpentine oil 1 ounce, mixed with 15 ounces starch mucilage. This is useful in hysteria and hysterical flatulence. It is also employed to destroy thread-worms. In such a case 4 or 5 ounces only should be given, so that they may be retained for a time.

Opium and Starch Enema.—Half a tea-spoonful of laudanum in 2 fluid ounces of starch mucilage. This is employed to relieve pain, to check diarrhœa, &c. As it is desired to retain it, a small quantity only is injected. The quantity of laudanum is for an adult. For a child one ought not to use such a drug without the sanction of skilled advice, which would also indicate the amount. But in the case of diarrhœa in children, sometimes the injection of 2 or 3 ounces of a thick solution of starch alone is productive of much good, by coating over the irritated and inflamed bowel, and calming its excitability.

Astringent Enemata.—If the opium and starch enema fails in diarrhœa, others may be tried. To the starch 2 tea-spoonfuls of hazeline may be added, or half a tea-spoonful of the liquid extract of witch-hazel. In the purging of typhoid fever, if these fail the following may be tried:—Oil of turpentine 30 drops, tincture of kino 2 tea-spoonfuls, liquid extract of opium 10 drops, mucilage of starch 2 ounces. Another form is as follows:—Subnitrate of bismuth 20 grains, tincture of catechu 1 tea-spoonful, liquor hydrochlorate of morphia 30 drops, mucilage of starch 2 ounces; mix and inject the whole.

Enema for Piles.—Inject daily a tea-spoonful of tincture of witch-hazel in 3 ounces of tepid water.

REMEDIES WHICH ACT UPON THE LIVER.

Stimulants to the Liver.

In this section there has been already considered a number of drugs which stimulate the liver and promote the secretion of bile. These have all been at the same time purgatives, and drastic purgatives when given in large doses—podophyllin, &c. (see p. 864). There are, however, several drugs which excite the liver to activity in various ways without producing purging. These must now be noted. Subsequently the drugs will be mentioned which diminish the activity of the liver. The chief of these are dilute nitro-hydrochloric acid (see p. 841) and chloride of ammonium (see p. 843). In enlargement of the liver in tropical countries, the latter drug is said to be beneficial, in doses of 5 grains and upwards. Phosphorus (p. 826), arsenic (p. 822), and antimony (p. 853), by their slow action upon the chemical changes going on in the tissues, also modify the activity of the liver, exciting it to renewed activity.

Drugs which Depress the Liver.

Any substance which markedly irritates the bowels, such as purgatives, diminishes the activity of the liver, and thus a powerful purgative, which does not at the same time stimulate the liver, will quickly relieve that organ, when some acute disorder is threatened. Quinine and opium are also powerful depressants of the liver to be employed in similar circumstances. Nevertheless, nothing will so quickly help to relieve the liver as certain restrictions in the diet. The avoidance of sugar, starch, and fat, the three substances in the assimilation of which the liver is most concerned, will diminish the quantity of material with which the gland has to deal or which it is its business to store up. In cases of sluggish liver, if, with such restriction of diet, active exercise be freely indulged in, and the bowels be kept free by an occasional saline purge, the waste products of the activity of the kidney will be rapidly removed, to the great relief of the organ.

SECTION IV.—DRUGS WHICH ACT ON THE GLANDULAR SYSTEM.

Stimulants to Enlarged Glands:
Iodine;
Lime and its Preparations—the Sulphide, Muriate, and Phosphate—Their Value in Scrofulous Diseases of Glands.
Cod-liver Oil.

Roughly speaking there are two different sets of glands in the body. There are, first of all, those glands whose business it is to produce, from raw material supplied by the blood, some fluid which is to be employed in the body for some special purpose, or which is to be separated and cast out of the body as waste. Thus there are the salivary glands (p. 137), producing saliva to moisten the mouth, to aid in swallowing, and to assist in the digestion of starch; there are the gastric glands, producing the gastric juice, the pancreas, producing the pancreatic juice, the intestinal glands, producing the intestinal juice, the liver (also a gland), producing the bile, all for purposes of digestion; there are the kidneys separating urine from the blood, and the sweat glands of the skin separating water mainly, to be cast off from the body; and there are the minute glands embedded in every mucous membrane for the purpose of keeping it moist; the drugs acting on these glandular organs are discussed in other sections, those of the digestive tract in Section III., those of the skin in Section VII. But, in the second place, there is the large number of glands which produce no special material, which have no outlet at all, which are interposed in the pathways of some of the nutriment absorbed from the bowel (the chyle, see p. 200) as it passes onwards to enter the circulation, or interposed in the pathway of those vessels —the lymphatics—which pick up fluid from the tissues and pass it back into the circulation (see p. 203). These glands have no outlet because they manufacture no special juice. Their business is to work up the chyle absorbed from the bowel, or the lymph absorbed from the tissues, by acting upon it in some way unknown to us, and fit it for becoming part of the circulating blood. Now if we think what an important function this is, a most vital part of the blood-forming business, if we realize how profoundly any serious disorder of the activity of these glands will affect the health of every tissue and organ of the body, we shall understand how valuable information would be as to the drugs which act upon these glands and as to the nature of their action. Let us take an illustration. "The glands of the bowels" is a popular phrase for the mesenteric glands (p. 201), and we know what apprehension is excited when there arises any suspicion of disease affecting them. The apprehension is well grounded. For we have already described (p. 200) how a large portion of the nutritive material of the food is picked up by vessels in the bowel, called lacteals, and carried direct to these mesenteric glands before being poured into the current of circulating blood. Any disease which seriously affects these glands may at once interfere with the course of this nourishing material, and may prevent its ever reaching the blood. It is not, then, to be wondered at if rapid wasting of body and exhaustion of strength are among the early and chief signs of such glandular disease. Scrofula (p. 431) is another illustration of the great importance of the lymphatic glands in the general nutrition of the body. Again, the important parts these glands play in the interception of poisonous material has been pointed out (p. 203), and the significant share they have in disseminating such diseases as cancer has been referred to (p. 434). All these facts illustrate how valuable would be any drug which was known to have direct and powerful effects upon glands, if it were possible to give it any direct application in disease. As a matter of fact, however, it can hardly be said that there are any medicines which have a specific action limited to glands. They can be acted upon only by that class of remedies which have a general effect upon the nutrition of the whole body by influencing the character of the blood or by modifying tissue change. The remedies which have these effects have already been noted in Sections I. and II. It will, therefore, be sufficient merely to mention those specially in use in affections of glands, and reference can then be made to the page where their action is more fully described.

Iodine, in some form, is a favourite remedy in chronic swelling of glands, and in scrofulous conditions. Sometimes it is applied as tincture, painted over the enlarged gland, sometimes it is given along with a preparation of iron, in the form of iodide of potassium; and a specially useful remedy, under such circumstances, is the syrup iodide of iron. For these preparations and their uses see p. 825.

Lime or calcium preparations stand probably next in regard for supposed virtues in glandular affections, specially such as are of a tubercular or scrofulous character (see p. 430). The main preparations and uses of lime have already been mentioned on p. 844. But there are other preparations, not named on that page, used almost exclusively for scrofulous and other enlargements of glands, for bone diseases, and in wasting diseases. They are as follows: —

	DOSE.
Sulphide of Calcium (or Sulphurated Lime), ...	$\frac{1}{10}$ to 1 grain.
Chloride of Calcium[1] (Muriate of Lime),.....	1 to 3 grains for children. 10 to 20 ,, for adults.
Phosphate of Lime, ...	10 to 20 ,,
Hypophosphite of Lime, ...	5 to 10 ,,

The so-called sulphide of calcium is principally used to check the formation of matter. If a gland be inflamed, and suppuration be feared, this preparation is given in doses of from $\frac{1}{10}$ to $\frac{1}{3}$ grain in pill four or five times a day, and is sometimes successful in checking it. In larger doses it is likely seriously to irritate the stomach. The chloride of lime was strongly recommended by the late Dr. Warburton Begbie, of Edinburgh, in the case of children with swollen glands of the neck, or children who suffered from weakness, loss of appetite, and diarrhœa, of a scrofulous character. "The cases in which I have had occasion most frequently to employ the muriate of lime have been instances of struma (scrofula), the most notable feature of which was the enlargement of the lymphatic glands in the neck. In the earlier cases which fell under my observation, recourse was had to the remedy, either because what appeared to be a fair trial had already been given to iodine, or its preparations, chiefly the iodide of potassium, and syrup of the iodide of iron, or to cod-liver oil. Frequently both iodine and cod-liver oil had been employed without appreciable benefit, or it had happened that these remedies had disagreed. Under such circumstances, then, muriate of lime was prescribed. For several years, however, with a growing and latterly extended experience of its virtues, I have not hesitated to order the remedy when no such proof was afforded, either of the failure, or of the intolerance on the patient's part, of the other medicines. I am not able to affirm that the remedy has always, that is, in every case, answered my expectations. . . . But it is in my power to assert, that many instances of very great enlargement of the cervical glands (glands of the neck) and several examples of other maladies, which will be shortly referred to, have apparently yielded to its use." One of the other maladies referred to is that met in childhood with symptoms resembling those of consumption of the bowels (tabes mesenterica, p. 166); and in it he observed the use of the remedy to be followed by the cessation of protracted diarrhœa and exhausting perspirations, by a diminution of fever, by improvement in appetite, the gaining of flesh, and a gradual restoration to the condition of health. Children suffering from loss of appetite, pallor, loss of flesh, protuberant belly, wasted limbs, and feverishness, he found greatly benefited by its use. He says that in such cases it requires to be taken for a considerable time—for weeks, it may be even months—before its beneficial effects are visibly produced. He recommends it to be taken after meals in milk, twice or thrice daily. It may be employed in the form of the solution of chloride of lime, of which 15 drops contain about 10 grains. This dose may be given to young persons (and less in proportion to children) thrice daily, and may be gradually increased to 30 or 40 drops. Too large a dose is likely to produce loss of appetite, sickness, and pain in the stomach. The phosphate and hypophosphite of lime are employed in similar affections, usually in combination with other substances, as compound syrup (see p. 817).

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[1] This is not the "chloride of lime" employed as a bleaching powder, and for purposes of disinfection, the proper name of which is *chlorinated* lime, though it is commonly called "chloride of lime." The two must not be confounded.

Cod-liver Oil is, however, perhaps of more value in glandular affections than even iodine or lime preparations. It is the oil extracted from the fresh liver of the cod, *Gadus Morrhua*, with the aid of heat. Its beneficial effects are not due to any specific action on glands or any other organs, since it is a food rather than a medicine; but it is much more readily absorbed and passed into the circulation than other oils. Not only does it thus readily gain access to the tissues, but it is also readily taken up by them, and thus it stimulates nutritive changes all over the body, and improves the general health. It quickly improves the quality of the blood, and is thus a blood tonic, while it is to be remembered that it can gain the blood current only by passing through the lymphatic glands. It may be applied externally in the case of feeble children, who cannot bear it on the stomach, by rubbing it into the skin. It appears to be of some value, even for nutritive purposes, when used in this way. But it is also used externally for scaly skin diseases to soften the skin, in psoriasis, for example. Internally it is given in all cases of defective nutrition, specially in glandular, scrofulous, and consumptive affections. For rickety children it is usefully combined with preparations containing lime, such as Parrish's chemical food (p. 817), or the compound syrup of hypophosphites. In all chest affections, specially in chronic bronchitis. it is very valuable. It exerts a most notable influence in diminishing the amount of the expectoration. In consumption of the lungs it is constantly administered, not because it directly tends to cure the disease, but because by its nutritive properties it does something to save the tissues that are specially subject to the wasting process. From time immemorial it has been a popular remedy for chronic gout, rheumatism, rickets, and scrofula. It acts as a tonic in nervous diseases, and may be combined with iron preparations, for neuralgia, hysteria; and in convalescence from all acute diseases, more particularly in damp and changeable climates, are its beneficial effects shown.

As a rule it is not to be given when the bowels are loose, lest the diarrhœa be increased. But if the diarrhœa arises from conditions of general weakness, &c., which the oil might help to rectify, it should be cautiously tried, in small quantities, in combination with something slightly astringent, such as chemical food. It will often prove useful in constipation.

Cod-liver oil is best given not immediately after food, and certainly not on an empty stomach, but an hour or two after food. Small quantities should be begun with, and they may be slowly increased, as the person becomes accustomed to them. Sometimes a dose can be tolerated without discomfort at bed-time, when it would occasion sickness at any other period of the day. Those who after patient trial cannot get accustomed to its use, ought not lightly to give up all attempts, but should try one or other of the numerous disguises now in the market—cod-liver oil emulsion, cod-liver oil and malt extract, peptonized cod-liver oil and milk (Carnrick's), &c. Many persons find it easily and agreeably taken when it is floated on the surface of claret. Its dose is from 1 tea-spoonful to 2 table-spoonfuls.

When it is persistently rejected by the stomach, combining it with pure ether should be tried—10 drops of pure ether to 1 tea-spoonful of the oil. The ether aids its digestion by stimulating the flow of pancreatic juice.

SECTION V.—DRUGS WHICH ACT ON THE LUNGS AND AIR-PASSAGES.

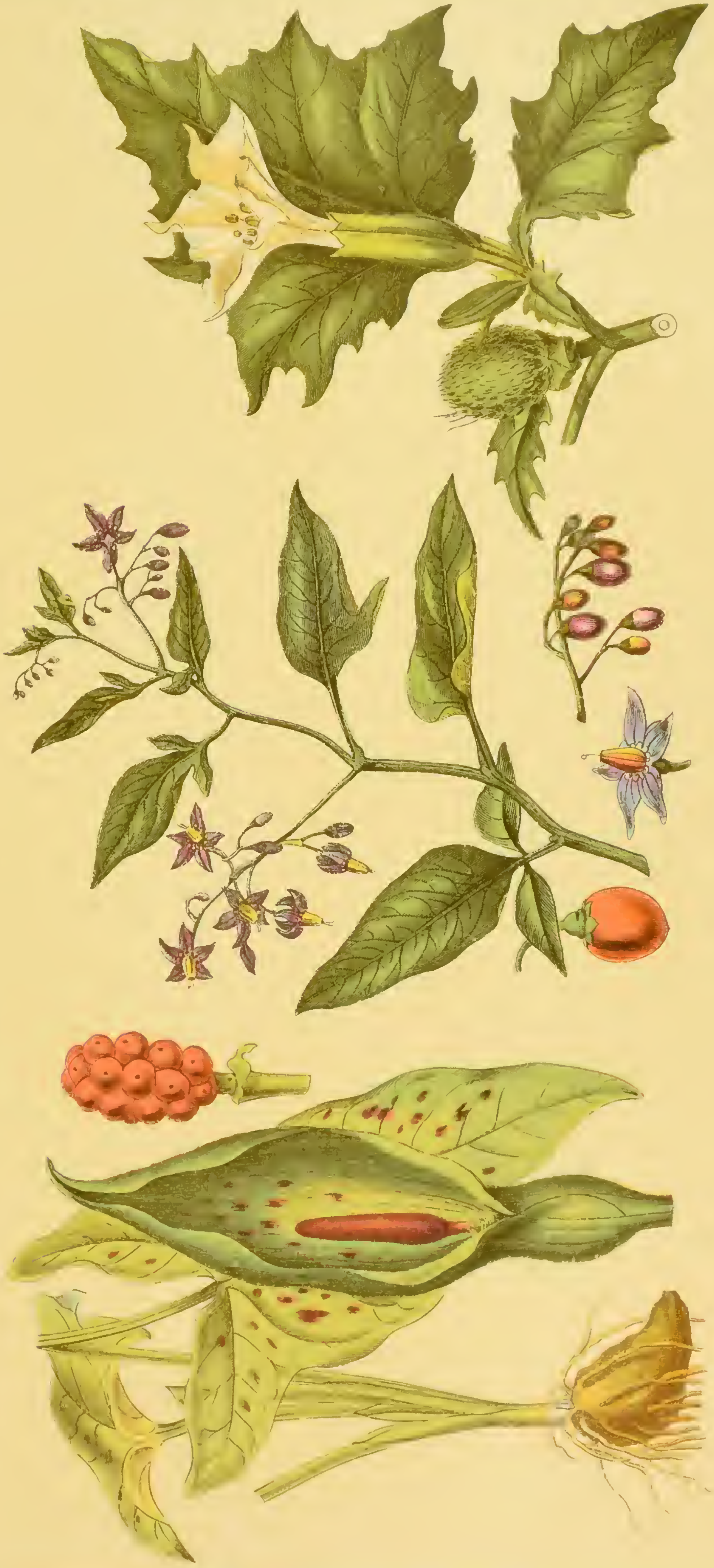
Remedies which Stimulate the Lungs and Air-passages.

Stimulants to the Circulation in the Lungs and Air-passages:
Ammonia, Digitalis, and Aromatic Oils.
Stimulants to Secretion from the Air-tubes—Expectorants:
Heat, Ammonia, Alcohol;
Senega; Balsams of Peru and Tolu;
Copaiba and Cubebs; Ammoniacum, Galbanum, Myrrh, Benzoin, Tar, &c.;
Ipecacuanha;
Inhalations of Carbolic Acid, Creasote, Iodine, Turpentine, Essence of Pumiline Pine, Eucalyptus Oil.

Remedies which Soothe the Lungs and Air-passages.

Remedies which Lessen the Circulation in the Lungs:
Heat and Blisters;
Antimony, Aconite, and Ipecacuanha.
Remedies which Diminish Expectoration:
Acids and Belladonna.
Remedies which Relieve Spasm:
Lobelia, Stramonium, Conium, and Tobacco.

Speaking broadly we may say there are two chief ways by which the lungs and air-passages can be influenced by drugs—the one is by stimulation, the other is by a soothing or depressing action. In order to understand how these effects may be brought about, it is necessary to recall some of the chief facts already mentioned in the section describing the structure and functions of the lungs and air-passages (p. 249). The lungs consist essentially of a large number of minute vesicles, cells, or sacs filled with air, communicating with one another by means of fine tubes—the bronchial tubes, and finally communicating with the outside air. In the walls of these air-cells are situated the vessels through which the blood flows; and while the blood flows through these vessels, it is exposed on all sides to the air of the vesicles, only a thin wall intervening between it and the air, so that exchanges readily occur between them. The tubes or air-passages have layers of involuntary muscle in their walls, by whose contraction the diameter of the tubes is diminished. The larger tubes have plates or partial rings of gristle in their walls to prevent their complete closure, but the smaller tubes are not so provided, and the contraction may be so great as practically to block the passage. Then the inner lining membrane of the bronchial tubes contains small mucous glands, which secrete a material for keeping the membrane moist, and this lining membrane has on its inner surface, except in the case of the finest terminations of the bronchial tubes, fine hair-like processes, or cilia (p. 252), which, moving always in one direction, sweep any material in the tubes upwards to the mouth, whence it is in time expelled. Now, it is plain that the gaseous exchanges going on in the lungs will materially depend upon the rate at which the blood is flowing through the vessels in the walls of the air-cells. This will, to a large extent, depend on the force and frequency of the contractions of the heart, for it is by the contractions of the heart that the blood is driven from the right side of the heart through the lungs, being purified on its course, to the left side, whence it is distributed throughout the body. This circulation through the lungs will, therefore, be quickened by any means which strengthen and stimulate the heart. Remedies which have this effect have been already named in Section II., and the chief of them are ordinary stimulants, ammonia, digitalis, squill, aromatic oils, such as have been named on p. 848 for flatulence, and senega. Another kind of stimulating effect is that which acts specially upon the lining membrane of the air-passages and their glands, increasing the amount of material poured out, relieving a dry and swollen condition of the membrane, and providing a larger supply of material to be swept out. This effect is produced by warm foods and drinks, and by ammonia and other alkaline remedies (see p. 843), by sulphur, by ipecacuanha, iodide of potassium, senega, squills, antimony, turpentine, camphor, balsam of Peru and Tolu, and aromatic oils. For example, in the early stage of



COMMON THORN APPLE - THORNY APPLE OF PERU
DEVIL'S APPLE - JAMESTOWN WEED
(Datura Stramonium)

WOODY NIGHTSHADE or BITTER SWEET
FELLOWWOOD
(Solanum Dulcamara)

CUCKOO PINT or WAKE ROBIN
LORDS & LADIES. COMMON ARUM
(Arum Maculatum)

acute bronchitis the lining membrane is swollen, red, and dry, great difficulty of breathing is experienced, and shrill wheezing sounds are heard widely spread over the lungs, and there is a dry and very irritable cough. The use of a remedy which causes the glands to pour out a copious secretion will speedily relieve the inflammation, will by moistening the membrane diminish its irritability, and will, thereby, greatly relieve the breathing. Again, in the latest stage of the same disease, and in others, accompanied by a scanty tough spit, which maintains a constant cough owing to the great difficulty of getting the tough phlegm swept up, any remedy which will increase the secretion, and so produce a more abundant and watery spit, will greatly relieve the symptoms. But, still more, the stimulating effect of various remedies is experienced by the muscular coat of the bronchial tubes, and by the cilia of the surface of the lining membrane, and the result of their increased activity is to sweep up more vigorously any offending material lying in the tubes. Cough will thus be increased, and that may seem at first blush a disadvantage; but so long as cough is the means of removing material which, if allowed to accumulate, will speedily fill up the air-passages, and render continued breathing exceedingly difficult or next to impossible, it is not a disadvantage, but a necessity. Finally, it has been pointed out in Section IX. A, p. 256, that the whole process of breathing is under the influence and control of the nervous system, and remedies may be given which will increase the excitability of the nerves of respiration, and so stimulate the breathing process.

Now all these actions may be reversed. Thus, the quantity of blood flowing through the lungs may be diminished and its speed lessened by means, such as mustard applications, which withdraw the blood to other organs, or by means which weaken the heart's action, such as aconite, antimony, and ipecacuanha. The quantity of mucus secreted by the glands of the bronchial tubes may be diminished by belladonna, stramonium, and hyoscyamus; and this effect it is very desirable to produce in chronic bronchitis and other diseases, with copious expectoration. The irritability of the whole lining membrane of the tubes may be lessened by warm food and warm applications, and by drugs like opium, ether, and chloroform. This effect it is very necessary to produce for the relief of cough of a dry, hacking kind. Such a cough is often due, not to the presence of any material to be expelled, but to the great irritability of the lining membrane, so that a mere whiff of cold air will start off a severe fit of coughing. The excitability also of the muscular coat of the tubes may be lessened, so that they tend to remain relaxed, allowing the tubes to be widely open. This is a most desirable result to achieve in spasmodic conditions, such as that of dry asthma, and which yields for a time at least to chloroform, ether, and nitrite of amyl (p. 837). Belladonna, stramonium, hyoscyamus, lobelia, tobacco, opium, and Indian hemp have a similar effect.

We see, then, that in disease of the lungs and air-passages the chief remedies employed are such as have either a stimulating or a soothing effect on the circulation, or on the secretion of mucus, or on the nerve and muscle part of the breathing apparatus. It may be noted that some stimulating remedies have an influence in all these various ways. Ammonia, for example, stimulates the circulation, the secretion from the glands, and the respiratory nerves; on the other hand, ipecacuanha depresses the circulation, but stimulates secretion and the nervous apparatus.

REMEDIES WHICH STIMULATE THE LUNGS AND AIR-PASSAGES.

Stimulants to the Circulation in the Lungs and Air-passages.

It is unnecessary to go over such remedies as stimulate the circulation in the lungs in detail. All heart tonics and stimulants (see p. 832) will naturally strengthen the circulation through the lungs. But it may be pointed out that a purplish or blue appearance of the skin of the face and lips is an indication of the need of some such stimulant. Ammonia, in the form of smelling salts, may be of use if the weakness is but temporary, and the carbonate of ammonia, in 5-grain doses repeated several times daily, and the aromatic spirit of ammonia (p. 843) are valuable, while tincture or infusion of digitalis with ammonia is, in weak conditions of the heart, a most effective combination. The pungent aromatic oils (p. 849) have a similar, though less durable, effect. Then a brisk purge, by unloading the liver and bowels, quickens the circulation through the lungs.

Stimulants to Secretion from Bronchial Tubes—Expectorants.

Expectorants is the term applied to such remedies as assist in the expulsion of phlegm from the air-passages. Now, a drug may be an expectorant which simply loosens the spit, so as to permit it to be more easily brought up. Warmth has such an effect, and may be applied to the chest in the form of a hot poultice, or may be employed in the shape of warm air or steam which is inhaled. Another drug may be an expectorant which simply increases the mechanical force brought to bear in coughing up the spit. Thus an emetic acts mechanically; the act of emptying the stomach serving also to expel material collecting in the bronchial tubes. For this purpose ipecacuanha wine is best, or if there is much depression an emetic dose of carbonate of ammonia—30 grains. The chief expectorants, however, are those which by their stimulant, or slightly irritating effect, increase the flow of blood to the lungs and air-passages and thus cause an increased flow of secretion. All the drugs mentioned under stimulants to the circulation will do this, but the chief are ammonia, alcohol, squill, senega, and balsams. Ammonia and alcohol have been already sufficiently discussed. Squill and its preparations have been noted on p. 833. Let it be remarked here that the fact that squills has a stimulating effect or irritating effect ought to prevent its promiscuous use in every case of cough, bronchitis, &c. Syrup of squills and ipecacuanha wine are the two domestic remedies for cough and lung affections. To the ipecacuanha wine there is little objection, to the syrup of squills there is often much. If cough is the result of an irritable condition of the bronchial tubes where there is little or no phlegm to expel, its use can only be hurtful by adding to the irritation, and in acute attacks of bronchitis it ought not to be employed. In chronic bronchitis, with copious spit, it is useful.

Senega is the dried root of *Polygala Senega*, a native of North America. It contains an active principle, **senegin** or **saponin**. Its preparations are:—

Powdered Senega,..........Dose, 10 to 20 grains.
Infusion of Senega,......... ,, 1 to 2 ounces.
Tincture of Senega,........ ,, ½ to 2 tea-spoonfuls.

Uses.—The powder of senega taken as a snuff acts as a powerful irritant on the nose, causing cough, sneezing, and a discharge. In any form it acts similarly on the stomach as an irritant, more or less powerful according to the dose, large doses causing heat, pain, sickness, and diarrhœa. It similarly stimulates the lining membrane of the air-tubes after it has passed into the blood, increasing the quantity of blood flowing in it, and the secretion from it, and increasing cough by the increased irritability. It is therefore used in the later stages of bronchitis when the spit is abundant, but ought not to be used in the inflammatory stage of any lung affection, which it can only aggravate. It probably increases the strength of the heart, and consequently in congestion of the lungs because of failure of the heart and threatened blocking of the lungs, it is of great value with carbonate of ammonia and tincture of digitalis.

Balsam of Peru is obtained from a tree, *Myroxylon Pereiræ*, growing in the state of San Salvador in Central America. The bark of the tree is beaten with a blunt instrument until it separates from the trunk without breaking off. After a few days the loosened bark is charred by torches, and in the course of a week the charred pieces fall off. From the bare trunk the balsam exudes and is licked up by rags applied to it, from which the balsam is afterwards obtained by boiling in water. The bark of the tree is not loosened all round, but only in strips, so that the vitality of the tree is not destroyed. On the following year the untouched strips are similarly treated. Thus an annual supply of balsam is got for thirty years, with the exception of once every five or six years, when the tree is untouched, in order that it may not be too soon exhausted.

Balsam of Peru,........ Dose, 10 to 30 drops mixed up with gum or white of egg.

Uses.—The balsam is a stimulant, specially to mucous membranes, stimulating stomach and bowels, as well as the heart and kidneys. It is for chronic bronchitis that it is most frequently given internally, in which it lessens the expectoration. It is also used in dysentery because of its stimulating action, and in other cases of discharge from mucous membranes, such as from the nose, ears, and genital organs. It is used in gleet. It is reputed also as an antiseptic and as destructive to parasites. It is much used in Germany for itch, being more agreeable than sulphur ointment. The person first takes a prolonged warm bath, soap being freely used. Thereafter the body and specially the parts affected are rubbed with 40 drops of the balsam, and this is repeated thrice daily for two days, when the cure is complete. It affords great relief in cases of itching (pruritus, see p. 323), being applied pure by means of a brush, and it is employed for ulcers and sores, chilblains, and sore nipples. An ointment for the destruction of lice is made with 20 parts of the balsam, 50 of olive oil, and 100 of petroleum.

Balsam of Tolu is obtained from the *Myroxylon Toluifera*, of New Granada. It exudes from the trunk of the tree after incisions have been made in the bark.

Balsam of Tolu,.........Dose, 10 to 20 grains.
Syrup of Tolu, ... ,, 1 to 3 tea-spoonfuls.
Tincture of Tolu,....... ,, 15 to 30 drops.

Tolu balsam has an effect similar to balsam of Peru, and is used chiefly for cough mixtures, in cases of chronic bronchitis. It is not used externally to the same extent as the latter; but is an ingredient of compound tincture of benzoin or Friars' balsam, used for wounds. In the latter combination it is very useful as an inhalation for tickling cough and hoarseness. A tea-spoonful is poured on the surface of boiling water and the vapour inhaled.

Copaiba is an oleo-resin obtained from incisions made in the trunk of *Copaifera multijuga*, found chiefly in the valley of the Amazon.

Copaiba, ...Dose, ½ to 1 tea-spoonful.
Oil of Copaiba, ,, { 5 to 20 drops mixed with gum or yolk of egg.

Uses.—Copaiba is a stimulant to mucous membranes, causing warmth in the stomach, and irritation, sickness, &c., if used in too large quantities. It is excreted by the kidneys, bronchial tubes, and skin, the unpleasant characteristic smell being readily perceived from the patient. In course of being expelled by the organs named it exerts a healing and antiseptic effect upon their lining membrane. It is thus a useful expectorant in chronic bronchitis, especially if the discharge be foul-smelling. But it is chiefly used for affections of the genito-urinary organs; for which, however, it ought not to be employed if the kidneys are the seat of any inflammatory affection.

Cubebs, in doses of 30 to 120 grains, is employed in the same circumstances as copaiba.

Various other oils and resins have similar effects, such as **Ammoniacum** (dose:—10 to 30 grains), a gum-resin, exuding after puncture from the stem of *Dorema ammoniacum*, found in Persia and the Punjaub; **Galbanum,** a gum-resin derived from *Ferula galbaniflua*, of India and the Levant, of which the dose is 10 to 30 grains; **Turpentine, Camphor, Benzoin.**

Benzoin is a gum-resin obtained from a tree —*Styrax Benzoin* or Benjamin-tree—indigenous to Sumatra, Borneo, and Java, and cultivated in the first-named place to a considerable extent. It is also called Gum Benjamin. It derives its properties from the benzoic acid it contains to the extent of 10 to 20 per cent. Its chief preparation is Compound Tincture of Benzoin—Friars' balsam—which is used mainly for wounds.

Benzoic Acid is contained not only in gum benzoin, but also in balsam of Peru, balsam of Tolu, and storax. It is an ingredient in the compound tincture of camphor—paregoric elixir—and the ammoniated tincture of opium. When taken internally benzoic acid creates a feeling of heat in the throat and of general warmth. It stimulates the lining membrane of the air-passages; and is used in chronic bronchitis, tending to diminish the excessive secretion. It also excites the secretion of urine, and stimulates the lining membrane of the bladder, being used in cases of chronic inflammation. Its dose is 10 to 15 grains.

Storax, a liquid balsam derived from the *Liquidambar orientalis*, is contained in the compound tincture of benzoin. Its actions and uses are similar to those of balsam of Peru. It is, like it, used for itch in the form of an ointment, of 1 oz. of storax and 2 drachms of olive-oil. After a warm bath the whole body except the head is rubbed with this, and one application is usually enough, but a second had better be given in twenty-four hours. It is not irritating to the skin, and this is a great advantage. It is used internally in chronic colds, especially of the lungs, but also of the urinary organs, in doses of 5 to 20 grains.

Myrrh, a gum-resin exuding from the stem of *Balsamodendron Myrrha*, of Arabia Felix and Abyssinia, is also used under like circumstances. Its dose is 10 to 30 grains. Of it there is a tincture (dose ½ to 1 tea-spoonful), which is an admirable astringent as a wash for spongy gums or ulcerated throat. It is given in combination with iron and aloes in pill (see p. 859). All these substances are only employed very occasionally in chronic bronchitis with profuse discharge, and after acute symptoms have passed.

Tar (Pix Liquida) is obtained by the destructive distillation of various pines, *Pinus palustris* and *Pinus sylvestris.* The preparations of tar used in medicine are:—

Tar Pills, 20 drops of tar made into pills with flour.
Tar Water,..................Dose, 1 or 2 pints daily.
(A mixture of 1 part tar and 3 parts powdered pumice-stone well shaken for 5 minutes with 10 parts of water.)
Syrup of Tar,...............Dose, ½ oz.
Tar Ointment.

Uses.—Tar is a stimulant to the skin and mucous membranes. Its chief use is in skin diseases, for which the ointment is applied, or the tar itself or oil of tar rubbed in on the affected patches, while tar pills or tar water or syrup are taken internally. It is also of value when employed as a soap. It is a stimulant also to the lining membrane of the air-passages, diminishing expectoration in chronic bronchitis and other chest affections, for which it is best used as vapour. A little tar is mixed with the twenty-fourth part of its weight of carbonate of potash and placed in a cup set in hot water over a night-lamp. The apartment is thus allowed slowly to be filled with the fumes, which are inhaled by the patient. The tar water may be used as an inhalation.

Oil of Birch-tar (Oleum Rusci) is used as an inhalation in chronic bronchitis: 10 drops are slowly converted into vapour by heat in a chamber in which the patient is.

Horehound, the leaves and tops of a perennial herb, *Marrubium vulgare,* of the labiate order, has long been a popular remedy in chronic cough and other affections of the air-passages, attended by much defluxion. It is stimulating, may be used as a tonic in dyspepsia, and also stimulates the skin and kidneys. In chronic rheumatism and in intermittent fever it has also been used. The infusion may be made with 1 oz. of horehound to 1 pint of hot water, and of this a wine-glassful is the dose. A syrup is made by adding sugar to the infusion.

Hyssop—*Hyssopus officinalis,* of the natural order Labiatæ—is another plant much used in domestic medicine, for purposes similar to those for which horehound is employed. A drachm of the herb to a pint of hot water yields an infusion, used as a tonic in dyspepsia, in chronic bronchitis, and as a gargle for sore-throat. It has also been employed in absence of the monthly illness.

Elecampane—the root of *Inula Helenium,* of the order Compositæ—was one of the most popular of ancient remedies. It was a domestic remedy for chronic bronchitis, dyspepsia, absence of the monthly illness, and in chronic eruptions of the skin. For these its stimulating properties made it sought after. It has recently been claimed for it that it could destroy the germ of consumption, the tubercle bacillus (p. 393). It is given as a decoction, made by boiling ½ ounce of root in 1 pint of water. The dose is from a half to one wine-glassful. It contains a substance, **inulin,** allied to starch.

Ipecacuanha has already been discussed on p. 852. It is well, however, to note here again its action so far as the lungs are concerned. It differs materially in action from senega, the balsams, myrrh, &c., already considered in this section, in this, that it aids the expulsion of discharge from the lung both by increasing the force of cough and by increasing the fluidity of the spit; but at the same time it does not excite but calms the circulation in the lungs. Now the other expectorants excite the circulation, and in any inflammatory conditions are apt to do mischief, and are, therefore, avoided. Ipecacuanha, however, from its reverse action, can with safety be employed even though acute inflammation be present, and is, indeed, in many such cases the appropriate remedy. It is very useful in the dry inflammatory stage of bronchitis, which it relieves by increasing the natural secretion of the parts and causing the irritable inflamed membrane of the air-passages to become moist.

Inhalations and Sprays are much employed in treating affections of the air-passages, as it has been shown that vapour of substances drawn into the lungs with the breath can penetrate to the inmost recesses of the lungs, and can also be absorbed from the lining membrane and pass into the circulation. There are various methods of employing substances by inhalation. The substance may be converted into vapour by the aid of dry heat, and the air of the apartment in which the patient is may thus be impregnated with the remedy, so that the patient inhales it without further trouble; or the material may be converted into vapour by means of boiling water, and the vapour inhaled along with the steam from the water. This can be done by means simply of a jug half filled with boiling water. The patient brings his mouth down to the opening of the jug, and a towel is arranged round the mouth and the edge of the jug to prevent escape of the vapour. The towel is so arranged that the nostrils are free, and the patient should inhale by the mouth, but breathe out by the nostrils. Instead of a jug, one of the various forms of inhalers in the market can be used (see Plate XIX. 3 and 4, and section on Medical and Surgical Appliances). Then the inhalation may be effected by means of a form of respirator. One of the best kinds is shown in Plate XIX. 2. It consists of a metal piece which fits over the mouth. The wall of the case is at one part double, and is perforated with small openings. The outer part of the double wall is movable on a hinge; and a piece of lint soaked in the medicated solution is placed between the two parts. The respirator is then fixed over the mouth, and air drawn through the soaked lint. In this case also the patient should inhale by the mouth and exhale by the nose.

Medicated solutions are also applied by means of spray producers (see Plate XIX. 1). The patient opens his mouth widely and the spray is directed to the throat, the patient inhaling at the same time. By this means the air-passages below the top of the windpipe do not receive nearly so much of the remedy, the back of the mouth and top of the gullet intercepting most of the material. Finally, remedies may be introduced into the air-passages in the form of smoke from a pipe, cigarette, or cigar, the remedy being mixed up with tobacco or used instead of tobacco.

The substances commonly employed in one or other of these ways may be either stimulating or soothing, or may be employed chiefly for antiseptic properties to destroy a foul smell, in cases where the expectoration is fœtid, or for astringent purposes for relaxed throat or hoarseness, or to control bleeding from the throat.

Stimulating and Antiseptic Inhalations.

Vapour of Carbolic Acid.
,, Creasote.
,, Benzoin.
,, Iodine.
,, Pine Oils.
Spray of Sulphurous Acid.
Vapour of Tar.
,, Turpentine.
,, Terebene.
,, Oil of Thymol.

Soothing Inhalations.

Vapour of Water.
,, Conium.
,, Nitre, as Nitre Paper.
,, Stramonium.
,, Tobacco.
Spray of Ipecacuanha Wine.

Astringent Sprays.

Alum Spray (10 grs. to 1 oz. water).
Sulphate of Iron Spray (2 grs. to 1 oz. water).
Lactic Acid Spray (21 grs. to 1 oz. water).
(For use in diphtheria.)
Tannic Acid Spray (60 grs. to 1 oz. of water).
(For bleeding.)

Carbolic Acid and Creasote are used as inhalations with the Coghill inhaler, already mentioned, in chronic bronchitis, and also in consumption, in both of which they are very useful. The strength of carbolic acid is 60 drops to 1 ounce of water, and of this 10 drops are placed on the lint of the inhaler. A solution of spirit of creasote of the same strength may be used, or 12 drops are placed on 8 oz. of boiling water. Creasote and carbolic acid may be mixed, 60 drops of each, 2 drachms of glycerine, and 1 oz. of water, of which use 10 drops.

Compound Tincture of Benzoin is used for hoarseness and in chronic bronchitis. A teaspoonful is poured on the surface of boiling water.

Iodine is employed in cases of offensive spit, and in chronic bronchitis. Thirty drops of tincture of iodine are mixed with 4 ounces of cold water, and the vapour is cautiously inhaled.

Turpentine and Pine Oils are the most commonly used of inhalations in cases of chronic bronchitis with excessive expectoration, and as antiseptics in cases of consumption. It has been asserted that the atmosphere of pine forests is extremely beneficial in lung affections, and the use of such an inhalation is an attempt to create an artificial atmosphere of the same kind. One ounce of turpentine to 5 ounces of cold water are used with a common inhaler. **Terebene**, prepared from it, may be used with the Coghill inhaler, 10 drops being placed on the lint. Of pine oils the oil of *Pinus sylvestris* (for wood oil) and *Pinus pumilio* are employed in a similar way, or may be used with boiling water as follows:—40 drops are mixed with 20 grains of carbonate of magnesia, and that with 1 ounce of water. One drachm (60 drops) is placed on hot water and inhaled.

Oil of Eucalyptus—the Blue Gum-tree—is used for inhalation. Ten drops on boiling water may be inhaled, or 5 to 10 drops may be placed on the lint of the Coghill inhaler, or it may be similarly used when mixed with terebene, in equal proportions. It is also given internally in chronic bronchitis and consumption as tincture, of which 15 to 60 drops are a dose, or in emulsion with mucilage of ordinary gum or gum tragacanth, 2 drops of the oil being the dose.

Sulphurous Acid Spray is employed chiefly for sore throats, hoarseness, &c. The strength employed is 5 drops sulphurous acid to 1 ounce of water.

Oil of Thymol is employed for antiseptic purposes, 10 grains being mixed with 20 of magnesia and 3 ounces of water, one drachm being inhaled from hot water.

REMEDIES WHICH SOOTHE THE LUNGS AND AIR-PASSAGES.

Remedies which Lessen the Circulation in the Lungs.

Nothing so quickly allays irritability of the lungs and air-passages as a diminution in the quantity of blood flowing through them. This diminution is not to be effected by creating difficulties to the flow of blood. On the contrary, everything which, by dilating the blood-vessels for example, permits the blood to flow more easily, will afford relief. What is desired, however, is the withdrawal of the blood to some other part of the body, and so getting rid of determination of blood to any particular part of the respiratory system, which is the first stage of inflammation. The chief means of effecting this are (1) heat, and (2) counter-irritation, that is the use of mustard poultices or blisters. For example, a mustard foot-bath would produce speedily relief, or a large hot poultice applied to the back or chest. A mustard poultice speedily reddens the skin, that is, withdraws blood to the surface, and a blister has a similar effect, its action being less fleeting. Heat may be applied directly to the air-passages in the form of steam. The inhalation of the steam of hot water from a jug will act by causing dilatation of the vessels of the upper air-passages, and will thus aid the onward progress of the blood. The steam may be poured into the apartment occupied by the patient by means of a bronchitis kettle (see Plate VIII.). Brisk purgatives, by taking the blood down to the bowels, will relieve the circulation in the lungs. For this purpose saline purgatives are best, since they also promote secretion of liquid mucus, and aid expectoration.

A second way of lessening the circulation is by the use of remedies which diminish the force and frequence of the heart, such as aconite (p. 834), antimony (p. 853), and ipecacuanha. The advantage of ipecacuanha has already been noted above, in that while depressing the circulation it increases the secretion of mucus, and strengthens the expulsive effort.

It is important also to note that rest and complete cessation of all muscular effort is an important aid to treatment designed to remove irritability of air-passages. It is common, for example, to observe how the slightest movement will cause certain kinds of cough to recommence immediately. Patients often recognize this fact by endeavouring to restrain to the utmost even the necessary movements of breathing.

Remedies which Diminish Expectoration.

The natural method of diminishing expectoration is by the removal of the condition which occasions it. This means the cure of the chronic bronchitis, &c., of which the expectoration is simply one of the consequences. Sometimes, however, in chronic cases when the quantity of expectoration is excessive, one is inclined to ask can nothing be done to diminish its bulk. The best treatment would be the administration of acid tonics, of which a list is given on p. 841. Acids have an undoubted effect in "drying up" the secretion.

Atropine, the active principle of belladonna (see section on Drugs Acting on the Nervous System), also acts to some extent in the same direction. Anyone taking belladonna or atropine is certain to complain of an excessive dryness of the mouth and throat, due to the diminished secretion from the glands of the mucous membrane. For this purpose from the $\frac{1}{120}$th grain to $\frac{1}{80}$th grain of atropine, or 5 drops of tincture of belladonna, might be taken several times daily. It is to be observed, however, that atropine and belladonna also act upon the nerves of the respiratory organs, quieting them. The efforts to expel the expectoration would, therefore, be lessened, and there would be the risk of the material accumulating in and blocking the lungs. It would, therefore, be well to combine the atropine with a stimulant, such as ammonia or senega, in the hope that there would be diminished secretion but increased expulsive effort.

Remedies which Relieve Spasm of the Air-passages and Cough.

This class of remedies and that of expectorants are the most important so far as the respiratory system is concerned. We have already referred to the fact that a prominent feature of the smaller bronchial tubes is the layer of muscular fibre in their walls, by whose contraction the passage is very much narrowed if not obliterated. In such a condition existing to any extent in the lung there would be great difficulty of breathing, from the greater or less degree of closure of the tubes. Such a state of affairs exists in spasmodic asthma. The muscular layer contracts because of stimulation reaching it along nerves, and the irritation of the nerves ending in the spasm may arise in the lungs themselves, or may exist in some other organs. Thus acidity of the stomach or some congestive condition of the liver will sometimes determine an attack of asthma. Again the irritation may be applied to the nerve centre for respiration (p. 257), and may be due to the character of the circulating blood, as in gout and rheumatism. A similar kind of spasm is that by which the opening in the larynx—the chink of the glottis—is closed, such as occurs in child-crowing. The second kind of spasm it is necessary to soothe is that which manifests itself chiefly in cough. Whooping-cough is essentially of a spasmodic character. In many instances, owing to the extreme irritability of the nerves of the air-passages, the slightest irritation, whether by breathing cold air, or the inhalation of dust, or irritation of the stomach, or irritation of the nose, as is often present in the form of polypus, is sufficient to set up a dry hacking cough. This is a kind of spasm also to be relieved by soothing remedies. The chief of such remedies are lobelia, stramonium, belladonna, hyoscyamus, tobacco, conium, as well as general sedatives like opium. It should not be forgotten, however, that the best remedy for spasm may often be some substance which may at first increase the spasm, such as ipecacuanha, by increasing the cough, but will speedily get rid of it by expelling the phlegm or other material whose stay in the air-passages is the cause of disturbance. Similarly an emetic may sometimes be the best remedy, by emptying the stomach and mechanically clearing the air-passages at the same time.

Lobelia.—The leaves and tops of *Lobelia inflata*, native to North America. The herb is also called Indian tobacco. Its preparations are:

Tincture of Lobelia,[1].............	Dose, 10 to 30 drops.
Etherial Tincture of Lobelia,...	,, 10 to 30 drops.

Uses.—In large doses lobelia causes burning pain, vomiting, and purging, acting as an irritant poison, and great prostration, headache, and giddiness result, and, in poisonous doses, failure of the heart and breathing. The remedy for this state of things is strong stimulants after the stomach has been emptied. It is chiefly employed in spasmodic asthma, being given in 10-drop doses while the fit is on, repeated every ten minutes till sickness is produced. In bronchitis, with a tendency to spasm, it is given in 10-drop doses with ammonia, senega, or other expectorants.

Stramonium, or Thorn-apple (Plate XII.), is discussed on p. 900. Its chief use is for nervous asthma, for which it is employed by mixing 15 grains of the dried leaves, or 7 of the fibres of the dried root, with sage leaves or tobacco and smoking it in a pipe or cigarette, inhaling the smoke. The leaves of *Datura Tatula*, a plant of the same genus, may be used instead of those of *D. Stramonium.*

Belladonna, hyoscyamus, and tobacco are discussed in the section devoted to Drugs Acting on the Nervous System. The value and use of belladonna in whooping-cough have been referred to on p 417.

Conium maculatum or Spotted Hemlock (Plate XI.) is used chiefly in the form of vapour as an inhalation to relieve cough in bronchitis, consumption, and whooping-cough (see p. 903).

Vapour of Hemlock (extract of hemlock 60 grains, solution of potash 1 drachm, water 10 drachms; mix.) Put 20 drops on a sponge in an inhaler containing hot water.

Nitrite of Amyl has been referred to as valuable in asthma on p. 837, and the inhalation of the fumes of nitre paper on p. 274.

Remedies for Cough have been stated at sufficient length on p. 284. One need only insist here on the fact that very frequently the best remedy for cough is some means which will loosen phlegm and permit of its ready expulsion, such as warm drinks, warm applications, and expectorants like ipecacuanha. The constant hacking exhausting cough, with little spit or none at all, demands, however, some soothing remedy. Inhalations of steam will help, and probably some actively soothing drug will be necessary, of which the best is one of the preparations of opium. (Refer to opium in the section relating to Drugs Acting on the Nervous System.)

Of popular remedies for cough, horehound (p. 882), marsh-mallow and colt's-foot are the chief.

Marsh-mallow (*Althæa officinalis*, natural order Malvaceæ) is a perennial herb, common to the greater part of Europe and naturalized in America, growing in marshy places near the sea. The root is chiefly used, but the leaves and flowers also. The root, collected in early spring or autumn, is dirty white externally and pure white within. It has a faint aromatic odour and a sweet mucilaginous taste. It is employed for its soothing effects on irritable inflamed surfaces. Poultices of the bruised root are employed to relieve inflammations of the skin. An ointment may be made by boiling the cut fresh leaves with lard for half an hour and then straining. In psoriasis of the hand it has proved effective. The ointment of the shops is used for irritable sores. In sore-throat marsh-mallow lozenges are exceedingly soothing. One kind of such confection is the *pâté de guimauve.* For irritable cough this or the syrup may be used. The syrup is made thus:—Of the dried and sliced root $1\frac{1}{2}$ ounces are steeped in 1 pint of cold water for twelve hours. The liquor is then pressed out and strained through muslin. To the liquor twice its weight of sugar is added and the whole dissolved by a gentle heat. When the syrup is cold, add half a drachm of rectified spirit to each ounce. The dose is from a tea-spoonful to a table-spoonful.

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[1] The American tincture is weaker; of it the dose is 30 to 120 drops.

Many varieties of mallow are used in a similar way.

Colt's-foot (*Tussilago farfara*, of the natural order Compositæ) is also a perennial herb, common in Europe, Asia, and America, growing in damp soil, in ditches, and along brooks. An infusion is made (1 ounce of dried leaves and flowers to 1 pint of hot water) for coughs and chronic bronchitis; and of it a tea-cupful may be taken at a time. The smoke of the burning root is inhaled in chest affections, and the root is also smoked in a pipe for lung affections.

Liquorice, Spanish-liquorice, the root and underground stem of *Glycyrrhiza glabra*, of the order Leguminosæ, is employed in cough and irritable conditions of the air-passages, because of its bland and soothing properties. It is also added in powder because of its sweetness to several preparations, such as the preparation of senna (p. 857). A fluid extract is prepared, and there is also the well-known dry extract, in sticks. It is often associated with linseed to yield a soothing drink for irritable states of the air-passages. Such a preparation is the infusion of linseed, made as follows:—

Linseed,	160 grains.
Fresh liquorice root, sliced,	60 grains.
Boiling water,	10 ounces.

Infuse 4 hours and strain. One to two ounces of this is a dose.

SECTION VI.—DRUGS WHICH ACT UPON THE SKIN.

Drugs which Increase the Amount of Sweat—Diaphoretics and Sudorifics:

Acetate of Ammonia;
Dover's Powder—Ipecacuanha and Opium;
Camphor and Antimony;
Jaborandi and Pilocarpine.

Remedies for Excessive Sweating:

Belladonna and Atropine—Their Use in the Night-sweats of Consumption;
Oxide of Zinc;
Acids and Acid Sponging.

Drugs which Improve the Nutrition of the Skin:

Iron, Arsenic, &c.;
Sassafras; Woody Nightshade (Dulcamara); Burdock; Rhus Toxicodendron (Poison Oak).

There are a great many remedies applied to the skin to produce merely local effects, such as ointments, washes, &c., and others for the purpose of acting upon deeper organs, such as stimulating liniments, blisters, and so on. These remedies it is not our purpose to discuss here. They are considered in a later section on Remedies for External Application. Here we wish to note the chief remedies employed to act upon the skin as a whole. The skin, as we have seen, has two main functions (see Section XI. A. p. 306): first an excretory function, by removing water with a small portion of salts in solution; and second, and perhaps the more important function, that of regulating the temperature of the body. The excretory function is effected entirely by the glands of the skin, but their activity may be stimulated by nerves, or, without any nervous stimulation reaching them directly, they may be excited to more vigorous action by an increased flow of blood to them owing to dilatation of the blood-vessels of the skin. The regulation of the body heat, however, may be affected both by the activity of the glands and by the activity of the circulation, together, or by one apart from the other. Thus dilatation of the blood-vessels of the skin and an increased flow of blood in the skin might exist apart altogether from any increased activity of the glands, and there would be an increased loss of bodily heat from the exposure of a greater quantity of blood to the external air. On the other hand increased sweating might occur, owing to nervous excitement, even when the quantity of blood flowing in the skin was less than usual. We know the sudden outburst of sweating that occurs in some people with fear, even when the marked pallor of the skin indicates contracted blood-vessels, and how, when a person is rallying from a threatened faint, beads of perspiration stand upon the forehead in curious contrast to the paleness of the face. The functions of the skin, then, may be altered by remedies (1) which affect the circulation in the skin, and (2) which act upon the glands. It appears that the glands may be acted upon in more ways than one. They are supplied with nerves, and there are some drugs, notably pilocarpine, which stimulate the nerve terminations in the cells of the glands and thus excite increased secretion, while atropine, the active principle of belladonna, has a reverse effect, paralysing the nerve terminations so that secretion is arrested. Other drugs excite not the nerve terminations in the glands, but certain parts of the central nervous system which are in communication with the glands. Thus in the upper part of the spinal cord there is believed to be a centre presiding over sweating, the exciting of which will cause an increase of sweating in the upper extremities, while a similar centre exists low down in the spinal cord, stimulation of which causes increase of sweating in the lower extremities. The condition of the blood affects these centres, exciting them if the oxygen of the blood be deficient; and nicotine, the active principle of tobacco, excites them also. Through these centres, by a reflex action (p. 86), impressions affecting sensory nerves throughout the body may affect the amount of sweating. In this way severe pain acts in causing sweating and sickness. It is also through these centres that mental emotions cause increase or diminution of the amount of perspiration.

Drugs which Increase the Amount of Sweat.

Drugs which increase the perspiration are called **diaphoretics** or **sudorifics**, according to the extent of the increase. Diaphoretics (Greek *diaphoreo*, to carry across) are drugs moderately increasing the sweat, and sudorifics (Latin *sudor*, sweat, and *facio*, I make) is the term applied to drugs with more powerful action, when the perspiration streams from the surface.

Heat is one of the simplest means of acting upon the skin to promote sweating. This it does by dilating the blood-vessels of the skin and increasing the activity of the circulation. Warm air, warm clothing, the warm bath, and warm spiced drinks, all these are well-known means of accomplishing the purpose sought. Alcohol has a similar effect, relaxing the blood-vessels of the skin and promoting a feeling of warmth, though actually cooling the skin by increasing the loss from the surface.

The chief sweating drugs are:—

Solution of Acetate of Ammonia (Mindererus' Spirit).
Dover's Powder (Ipecacuanha and Opium).
Camphor. Antimony. Pilocarpine.

Solution of Acetate of Ammonia (p. 843), when given internally, acts on the skin, if the body be kept warm, and on the kidney if the skin be kept cool. Its dose is from 2 to 6 tea-spoonfuls. It is one of the mildest and safest of sweating remedies, peculiarly suitable for children, used in fevers, those attended by rash, and feverish colds, and when fever is present from other causes, as in inflammation of the lungs. It soon makes the dry hot skin pleasantly moist. It is usefully combined with spirit of nitrous ether to act upon the kidneys (see next section). The drug acts apparently upon the cells of the sweat glands, as well as dilates the blood-vessels of the skin.

Dover's Powder, the compound powder of ipecacuanha and opium (see p. 852), is one of the most commonly used of sweating powders. Its dose for an adult is 10 grains; and it should not be given to children. Its effect in the early stage of cold-in-the-head, or influenza-cold is remarkable, if it be taken soon enough. It commonly dispels the dull headache, the pains in the bones, and the sickness, as if by magic. The person ought to take the powder, use a footbath, get into bed, and have a warm drink; and then the beneficial effects are speedily felt. Ipecacuanha itself acts upon the skin, and may be given as powder, or as the wine, to children; and opium alone, or any of its preparations, also increases sweating (see Section VIII.), but they are best given in combination, except in the case of children.

Camphor (see p. 850) and other aromatic substances increase the production of sweat. Camphor is specially employed in cases of catarrh or cold-in-the-head in 2 or 3 grain doses, or as the spirit of camphor and as vapour.

Antimony was at one time much used for this purpose in the form of James' Fever Powder (p. 853), but is little employed nowadays.

Pilocarpine is an alkaloid derived from the dried leaflets of *Pilocarpus pinnatifolius*, or *Jaborandi*, a plant found in South America. Of jaborandi there is an extract (dose: 2 to 10 grains), an infusion (dose: 1 to 2 fluid ounces), and a tincture (dose: $\frac{1}{2}$ to 1 tea-spoonful), and in America a fluid extract of pilocarpus is obtained (dose: 5 to 60 drops). Of the alkaloid pilocarpine itself the dose is $\frac{1}{20}$ to $\frac{1}{2}$ grain, as nitrate or muriate (hydrochlorate) of pilocarpine.

Uses.—If a dose of from $\frac{1}{20}$ to $\frac{1}{3}$ grain of the muriate of pilocarpine be injected under the skin of a person, it produces in a few minutes flushing of the face and breast, and sweat appears first on the forehead and in the arm-pits and then over the whole body. Saliva is increased, the tear glands become more active, and the secretion of wax in the ears and of mucus in the throat and nostrils is increased. The gastric glands and intestinal glands are sometimes excited, and diarrhœa sometimes occurs; while the kidney is stimulated, and the flow of milk in the breast glands is sometimes, though not always, augmented. By irritation of the stomach it sometimes causes sickness and vomiting. The pulse is increased, and vision becomes indistinct by contraction of the pupil. It produces, sometimes even in small doses such as that named, unpleasant symptoms, such as palpitation, giddiness, retention of urine and strangury, and collapse, and it brings on in women the monthly flow. These bad effects can be arrested by the use of atropine. It is chiefly used in dropsy to promote removal of the accumulation of water, which it is well fitted to do, since in a few hours the body may lose eight pounds weight from the combined sweating and flow of saliva. It is found useful in arresting convulsions dependent upon kidney disease. The enormous loss of water from the body it occasions has been found to promote the cure of pleurisy with effusion by withdrawing fluid from the chest-cavity. In asthma and bronchitis with much expectoration it has yielded benefit, and it has cured a persistent case of hiccough which resisted all other treatment. It has also been employed to promote sweating in fevers and feverish colds, and in itching skin diseases; and it has been employed, but without much success, in eye diseases, specially in separation of the retina, from the notion that it might remove the fluid beneath the retina which is the cause of the detachment. Pilocarpine is an antidote to poisoning by belladonna and *vice versa*.

Remedies for Excessive Sweating.

The chief remedies for excessive sweating, that is drugs which diminish the secretion of sweat, are belladonna, and its active principle atropine, and zinc.

Belladonna and **Atropine** are discussed in Section VIII. It is well to note here, however, the powerful effect they have in diminishing sweating. When belladonna is taken internally the throat and skin are both dry. The effect upon both is due to a paralysing influence upon the secreting cells of the glands. The secretion of saliva can be completely arrested by the drug, owing to the paralysis of the cells. It is, therefore, a most valuable drug whenever any such effect is desired. Thus in the night-sweats of consumption a pill of the extract of belladonna, $\frac{1}{2}$ to 1 grain, or $\frac{1}{200}$ grain of atropine is often sufficient. The excessive sweating of acute rheumatic fever may be similarly arrested. When the sweating complained of affects only one part of the body, say arm-pits, feet, &c., the remedy may be employed as a paint to the part in the form of the extract made somewhat thin with glycerine, or the tincture may be rubbed in as a lotion. It is a similar action which makes belladonna very useful for diminishing or arresting the flow of milk from the breast. It should be applied as a paint of the extract, and the breast covered with a square of lint, a piece being cut out of the centre for the nipple.

Zinc Salts, specially the oxide of zinc, 1 to 3 grains in pill, are also valuable in excessive sweating. A pill of

2 grains oxide of zinc,
$\frac{1}{6}$ grain belladonna extract, and
$\frac{1}{4}$ grain extract of nux vomica,

given at bed-time, is likely to be sufficient to check the night-sweats of consumption.

Acids, especially the dilute aromatic sulphuric acid in doses of 10–20 drops in water, are employed successfully to check the sweats of consumption. Any of the dilute acids mentioned on p. 841, freely diluted with water, and used to sponge the surface of the body, will often effectually control excessive perspiration.

Drugs which Improve the Nutrition of the Skin.

There are numerous drugs which act upon the skin, not in any obvious manner, and without so markedly influencing the perspiration as the two classes of drugs which we have considered already in this section, but by gradually improving the nutrition of the skin. They are such drugs as we have considered in Section I., which imperceptibly modify the chemical changes going on in the tissues, and ultimately induce healthier action, namely:—Iron (p. 817), arsenic (p. 823), sulphur (p. 827), sarsaparilla (p. 828), guaiacum (p. 828), mezereum (p. 829). The last four act as stimulants to the circulation in the skin, and thereby also increase the action of the glands. Senega, although it is chiefly used as a stimulant to the air-passages (p. 880), has a like effect upon the skin, thereby promoting the action of the skin. Serpentary (p. 841) may be grouped along with these for its stimulating effect upon the circulation in the small blood-vessels.

Sassafras, the dried root of the sassafras tree (*Sassafras officinalis*), growing in the United States and Canada, is sometimes used in cases of chronic skin diseases, such as those for which sarsaparilla, guaiacum, &c., are employed. It is a stimulant to the skin, and was formerly used in chronic diseases of the skin and in syphilis, the popular belief being that it "helped to purify the blood." It increases also the action of the kidneys.

Dulcamara, Woody Nightshade, or Bittersweet, the dried young branches of *Solanum Dulcamara,* is another remedy which improves the condition of the skin, and has long been used as a popular remedy for scaly diseases of the skin, psoriasis, eczema, acne, and others. It has also been employed in chronic bronchitis and other lung affections. It can act, however, as a poison, slowing the heart and breathing, and causing death with convulsions. Of the infusion of dulcamara the dose is 1 to 2 fluid ounces. The infusion is made with 1 ounce bruised dulcamara and 10 ounces boiling water infused one hour and strained.

Burdock, the root of *Lappa officinalis,* of the Compositæ order, has long had a popular reputation for the cure of chronic skin diseases, as well as for rheumatism, gout, scrofula, chest affections, &c. It is used both as an internal medicine, and for outward application. For the former a decoction is made by boiling 2 ounces fresh-bruised root in 3 pints of water down to 2 pints. A pint of this should be taken daily. Another preparation is made by adding 1 pound of ground burdock seed to a gallon of whisky, letting it stand for two weeks, and then decanting. Of this 2 or 3 tea-spoonfuls are taken after meals. The fresh leaves bruised, the juice from fresh leaves, and lotions made by boiling the leaves or root with oil, are used for ulcers, wounds, and various other skin affections.

Rhus Toxicodendron—Poison Oak, Poison Ivy—is a plant belonging to the natural order Terebinthaceæ, to which also the **Common Sumach** (*Rhus glabra*) and the **Sweet Sumach** (*Rhus aromatica*) belong. It is indigenous to Canada and the United States. The emanations of the living plant and the juice of the fresh leaves produce an eruption on the skin attended by itching, swelling, pain, and fever. For this lime-water or lead lotion is a good application. A tincture is prepared of which the dose is 1 to 5 drops in water thrice daily. It has been recommended in chronic skin affections, in rheumatism, in incontinence of urine due to weakness of the bladder, and in paralysis dependent upon concussion of the spine. The tincture is known by the author to have been taken internally by a person who was very much annoyed by the growth of warts on the fingers, and with perfect success, the warts completely disappearing after some time. There seemed little doubt that the drugs exerted some special action on the nutrition of the skin. It is for this reason he deems it proper to give the remedy a place in this section.

The common and the sweet sumach have both been used for their astringent properties as gargle, and for application to wounds, and also internally as a tonic to the bladder. An infusion of leaves or bark, 1 oz. to 20 of water, may be used.

SECTION VII.—DRUGS WHICH ACT UPON THE KIDNEYS, BLADDER, AND GENERATIVE ORGANS.

Drugs which Increase the Quantity of Urine—Diuretics:
Water and Watery Drinks;
Salts of Potash and Soda;
Ammonia; Digitalis; Squill;
Sweet Spirit of Nitre;
Broom-tops; Juniper; Copaiba; Hops; Pareira; Buchu; Bearberry;
Chimaphila; Dandelion.
Remedies which Soothe the Kidneys.
Drugs which Stimulate the Bladder.
Drugs which Allay Irritability of the Bladder.
Drugs which Act on the Generative Organs:
Pennyroyal, Savin, and Rue;
Black Snake-root (Cimicifuga); Blue Cohosh (Caulophyllum);
Pulsatilla and Beberine.

DRUGS WHICH ACT UPON THE KIDNEYS.

The chief object desired from drugs, given to act upon the kidney, is to increase the flow of urine. This result may be sought because the flow is scanty, or because of some disease of the kidney or bladder, or, while the urinary organs are healthy, they may be stimulated in order to effect the removal of some dropsical accumulation of fluid in some part of the body, or the kidney may be stimulated in conditions of fever in order to aid in diminishing the fever, and to sweep out of the body waste materials which the fever has produced. Drugs which have the effect of increasing the flow of urine are called **diuretics** (Greek, *dia*, through, and *oureo*, I pass water). It is necessary, however, to observe, that drugs which increase the activity of the kidney, and increase the quantity of water produced by them, are not always the appropriate remedy when there is a scanty flow of urine. A person, for example, may pass very little water at a time, or may be unable to pass water at all. It would be a very great mistake to give that person a dose of spirits of nitre, as is common, or gin, or some similar remedy, for the fault may not exist in the kidneys at all, which may be doing their work quite satisfactorily; the fault may be in the bladder which has lost the power to expel the urine, or which is prevented expelling the urine by some spasmodic condition of the neck of the bladder, or some inflammatory swelling which obstructs the flow of urine. Under these circumstances to give medicine which would increase the flow of urine into an already full bladder, would only be greatly to add to the uneasiness, discomfort, and pain which the person is suffering. What is evidently needed is some means of emptying the bladder. The relation between the kidney and bladder is set forth in Part I., Section X. A. p. 288, where it is explained that the urine, secreted in the kidneys, is passed down the ureters, a fine tube leading from each kidney to the bladder, and that the urine flows into the bladder constantly, but drop by drop. When the bladder is full, owing to a nervous action the muscle guarding the neck is relaxed, and the urine expelled by the contraction of the muscular walls of the bladder (see p. 294). The distinction then between the secretion of urine by the kidney and its expulsion by the bladder must never be forgotten. It is only in the cases where it is desired to act upon the kidney that diuretics are given.

Drugs which Increase the Quantity of Urine.

The following is a list of the chief drugs which increase the quantity of urine:—

Water in large quantities.
Aerated waters.
Acetate, citrate, nitrate, and bicarbonate of potash.
Bicarbonate and phosphate of soda.
Citrate and carbonate of lithia.
Ammonia,
Digitalis, } By strengthening the heart.
Squill,
Nitrous ether.
Broom-tops.
Juniper.
Copaiba.
Hops.
Pareira.
Buchu.

Of water and aerated waters it is not necessary to say much. All watery drinks increase the quantity of urine, because the water is absorbed from the stomach and passes into the blood, and is speedily excreted by the kidneys. If one drinks, while fasting, several glasses of spring water, one after the other, at intervals of 15 or 20 minutes, after the second or third glass, water will be passed less coloured than usual and in quantity very nearly equal to the first glass. If one goes on drinking, the urine will keep pace with the water imbibed, and after many glasses will be little different from spring water. This clearly would produce a flushing-out action on the kidneys and bladder, and would also remove much waste material from the body, being beneficial in gouty conditions and as a preventive of gravel. In many cases of inflammation of the kidney, where one wishes to pass a larger quantity of water through the kidney without irritation, water and watery drinks, milk with aerated waters, are very suitable.

The saline substances in the above list—acetate, citrate, &c., of potash, and the salts of soda and lithia—have been noted elsewhere (pp. 818, 819). These are capable of acting both on the bowels and the kidneys, at least the salts of soda and potash are, and very often the relief they produce by their action on the bowels has a very beneficial effect on the kidney. In feverish conditions they are useful. The salts of potash are commonly given along with the sweet spirit of nitre in dropsy; they and the soda salts are commonly used when it is desired to diminish the acidity of the urine, and lithia is specially given for such purposes in gouty and rheumatic conditions.

Ammonia, digitalis, and squill all act upon the kidney indirectly by their tonic action upon the heart and blood-vessels. Whenever dropsy with scanty, high-coloured urine is the consequence of feeble and irregular heart, digitalis is the remedy to be used (see p. 832), though it is usual also to combine it with the aromatic spirit of ammonia or carbonate of ammonia (p. 843), to aid the stimulating action on the heart. When digitalis fails, the addition of squill (p. 833) helps to produce the desired effect, after the bowels have been relieved by blue-pill.

Spirit of Nitrous Ether—Sweet Spirit of Nitre—the dose of which is ½ to 2 tea-spoonfuls, is one of the most commonly used of remedies for increasing the quantity of urine. It relaxes the smaller blood-vessels of the skin and kidneys, thus allows a freer flow of blood through them, and causes a corresponding increase in the urine and sweat. It is familiarly used in feverish states, for this action that has been described results in cooling the body. It should not be used in acute disease of the kidney, because of its effect in promoting a fuller supply of blood to the kidney.

Broom-tops (*Scoparius*), the fresh and dried tops of the shrub *Sarothamnus scoparius*, abundant in Great Britain. It belongs to the leguminous order of plants, to which the pea and bean also belong. It contains a poisonous alkaloid, **spartein**, and another principle called **scoparin**. Its preparations are:—

	DOSE.
Decoction of Broom-tops, ...	1 to 3 fluid ounces (2 to 6 table-spoonfuls).
(1 oz. dry tops, 1 pint water; boil 10 minutes and strain.)	
Juice of Broom-tops, ...	1 to 2 tea-spoonfuls.

Broom-tops are used only for their action on the kidneys. They are employed in cases of dropsy due to chronic disease of the kidney, usually along with digitalis or acetate of potash. The active principles of the drug appear to excite the secreting cells of the kidney, and on this account, while it is useful in chronic disease, it is hurtful in acute disease of the kidney, where soothing treatment is desired.

Juniper, the fruit of *Juniperus communis*, a shrub 4 to 6 feet high, whose fruit—juniper berries—is berry-like in appearance. Its preparations are:—

	DOSE.
Oil of Juniper (distilled from the fruit),..........................	1 to 4 drops.
Spirit of Juniper,....................	30 to 60 ,,
Compound Spirit of Juniper, ...	2 to 4 tea-spoonfuls.
(Contains oils of juniper fennel and caraway, and alcohol.)	

Uses.—Juniper is contained in gin and hollands, and it is because of its virtues that these are recommended to increase the quantity of water. Its action resembles that of turpentine. It acts as a stimulant to the stomach, expels wind, and relieves spasm. It directly stimulates the kidney, increasing the urine, but if given in excessive doses causes inflammation and strangury.

Copaiba (see p. 881) is sometimes used in dropsy, dependent upon affection of the liver or heart; but its irritating properties render it liable to do harm if the kidneys are diseased. Its chief use is for catarrhal conditions of the bladder and urinary outlet.

Hops act slightly upon the kidneys, and beer possesses such a property on account of their presence. Besides the infusion mentioned on p. 841, there is a tincture, of which the dose is ½ to 2 tea-spoonfuls.

Pareira Root—Pareira Brava—the root of *Chondodendron tomentosum*, a woody climber of Brazil and Peru, known as *Cissampelos abutua*. Its preparations are:—

Powdered Pareira Root, ...Dose, 30 to 60 grains.
Decoction of Pareira,............... ,, 1 to 2 ounces.
(Sliced root 1½ oz., water 1 pint; boil 15 minutes, strain. Add water to make a pint.)
Infusion of Pareira, ...Dose, 1 to 2 ounces.
(1 oz. bruised root, 1 pint boiling water; infuse 2 hours.)
Extract of Pareira, ... Dose, 10 to 20 grains.
Liquid Extract of Pareira, ,, ½ to 2 tea-spoonfuls.

Uses.—Pareira is a bitter tonic. It stimulates the kidney, increasing the flow of urine. It is also a stimulant to the mucous lining of the urinary passages; and it is in chronic catarrh of the bladder that it is most commonly used, when it promotes healing and lessens the discharge.

Buchu Leaves are the dried leaves of *Barosma betulina*, *crenulata*, and *serratifolia*, three shrubs belonging to the order Rutaceæ, indigenous to Cape Colony. Its preparations are:—

	DOSE.
Infusion of Buchu,...................	1 to 2 ounces.
(Infuse 1 oz. of the leaves for 1 hour in 20 ozs. boiling water and strain.)	
Tincture of Buchu, ...	1 to 2 tea-spoonfuls.
Liquid Extract of Buchu, ...	20 to 45 drops.

Buchu is used chiefly as infusion, and for the same purpose as pareira root. It is a tonic, exciting a feeling of warmth in the stomach, quickens appetite and digestion, and is used in South Africa in doses of 20 grains of the powdered leaves for similar effects on the bowels in cases of diarrhœa and dysentery. It acts on the kidneys and bladder as a stimulant, and is often used with infusion of bearberry leaves (*uva ursi*).

Bearberry Leaves, the dried leaves of *Arctostaphylos uva ursi*, a trailing evergreen shrub of the order Ericaceæ, growing in most parts of Europe, Northern Asia, and North America. Its preparations are:—

Infusion of Uva Ursi,............ (1 oz. leaves, 20 ozs. boiling water, infuse 2 hours and strain.)	Dose, 1 to 2 ounces.
Fluid Extract of Uva Ursi,......	,, 30 to 60 drops.

Bearberry leaves contain tannic and gallic acids, and are therefore astringent. It also contains a principle called **arbutin**, to which its effects on the kidneys and bladder appear to be due. It increases the flow of urine, and stimulates the urinary passages; but in too large doses it occasions vomiting and purging. It is in chronic diseases of the kidney and bladder it is most useful. By its astringent effect on the bladder it frequently relieves pain and irritation due to excessive sensibility of the bladder. It has also been used in chronic bronchitis, and in chronic discharges from the bowels and womb, and in bleeding from the womb.

Triticum Repens or **Couch-grass**, a common weed, with a long jointed root-stock, is used to yield a decoction for cases of irritation of the urinary passages. The root-stock is the part employed; 2 to 4 ounces of it are bruised and mixed with 2 pints of water. The mixture is boiled till it is reduced to 1 pint, and then drained. A wine-glassful may be taken frequently. It increases the flow of urine, and soothes the urinary passages, and was supposed to aid the removal of gravel from the bladder.

Alchemilla arvensis (Parsley Breakstone) is employed for the same purposes as the above; of the flower-heads 1 oz. is boiled with 20 of water for ten minutes, and strained. A wine-glassful, thrice daily, is taken.

Chimaphila is a remedy used in America, and known under the name of Pipsissewa, Prince's Pine, and Wintergreen. The plant is the *Chimaphila umbellata*, of the Ericaceæ order, and the leaves are used as powder, of which the dose is 30 to 60 grains, or to yield a fluid extract, of which the dose is 1 teaspoonful.

It contains tannin, and is astringent. It is also a stimulant, the fresh bruised leaves reddening the skin. It resembles bearberry in its effects, and is used popularly in America for kidney diseases, as uva ursi is employed, and for rheumatism, both internally, and externally as a poultice of the leaves to the painful joints. It is said, also, to be useful in scrofulous disease of glands and skin.

Dandelion also acts upon the kidneys (see p. 858).

Remedies which Soothe the Kidneys.

Remedies which soothe the kidneys will be such as will withdraw blood from them, and so lessen the activity of the circulation through them, and also such as will directly act upon the secreting cells of the uriniferous tubules (see p. 290) and diminish their activity. Nothing will more quickly or effectively accomplish the former result than drugs which act briskly upon the skin and bowels, causing free sweating and purging. It has already several times been pointed out that the skin and kidneys work together, the increased activity of one being accompanied by diminished activity of the other. If the skin, therefore, be kept warm and sweating, for example by a dry external heat, the activity of the kidney will be lessened and the quantity of the urine diminished. Such a result is quickly obtained by a Turkish bath. Similarly a mustard foot-bath, or a large mustard poultice to the loins, by drawing the blood to the surface, will relieve the kidneys. These are always the appropriate measures to be taken in acute disease of the kidneys. Then if the skin is kept warm, acetate of ammonia and spirit of nitrous ether will encourage sweating; and in very urgent cases pilocarpine (p. 887) will induce copious perspiration, unburdening the kidneys. Simultaneously with such remedies, the administration of drugs which promote the removal of water by the bowels, such as the compound powder of jalap (p. 861), compound colocynth pill (p. 860), or blue-pill, followed by double-strong seidlitz powder, will greatly aid in relieving the kidneys and reducing inflammatory disturbance.

It is not so easy to say by what means the cells of the kidney may be directly acted upon in order that their secretory activity may be lessened. The author believes that belladonna and its active principle atropine have such an effect (see Section VIII.), and perhaps ergot (p. 835), by contracting the blood-vessels diminishes the supply of blood to the kidneys, and consequently lessens their activity. In acute inflammatory affections, relief to the kidney is, however, to be obtained by the other measures described.

DRUGS WHICH ACT ON THE BLADDER.

Drugs which Stimulate the Bladder.

These drugs have already been stated in preceding paragraphs—copaiba and cubebs (p. 881), pareira brava, buchu, and bearberry (p. 891).

Strychnine (see p. 895) exercises a tonic influence on the muscular walls of the bladder, and may be of value where there is weakness of expulsive power. The bladder may be excited to empty itself by the application of a cold wet sponge close up between the legs. The effect of mental impressions in setting agoing the nervous action that causes emptying of the bladder is well seen by the sound of falling water tending to produce evacuation. An old surgeon, Boerhaave, used to help a patient, unable to pass water, by making an attendant pour water from a height into a basin in a neighbouring room, so that the sound was heard by the patient, ignorant of the little trick played on him, and started the flow.

Remedies which Allay Irritability of the Bladder.

Heat is a powerful means of soothing the bladder, applied either externally as a hot sitz bath, or as a hot sponge or poultice, or taken internally as a hot bland drink such as barley water or linseed tea. Opium, hyoscyamus, and belladonna (all discussed in Section VIII.) are the chief drugs employed; and they are best given in the form of suppositories. But it must not be forgotten that excessive acidity of the urine or other condition may be the cause of the irritability; and the rectifying of this condition would be necessary to permanent relief.

Remedies that Act on the Generative Organs.

It is not desirable to do more than notice a few of the drugs employed to act upon these organs, specially upon the womb.

Many drugs are employed to excite the womb in order to promote the flow of the monthly discharge when it has been arrested or has failed to appear. Of these the one in common use is **Pennyroyal,** the leaves and tops of *Mentha Pulegium*, or *Hedeoma*, the American pennyroyal. It is used as a hot infusion, ½ oz. to 1 pint of water infused for half an hour, and given in half a wine-glassful doses at repeated intervals. **Savin Tops,** the fresh and dried tops of *Juniperus Sabina*, and **Rue** are sometimes employed for a like purpose, as also are drastic purgatives. These are mentioned only that a warning against their use may be given. They produce effects by the intense irritation of stomach and bowels which they set up, irritation which has often proved fatal.

The American **Black Snake-root** (*Cimicifuga racemosa*, or *Actæa racemosa*) is very often used as a uterine stimulant. It has proved useful also in rheumatism, neuralgia, sick headache, and lumbago, in doses of 15 to 60 drops of the tincture, or 5 drops every hour. A decoction is prepared by boiling 1 oz. in 20 ozs. water, of which 1 oz. is a dose. A liquid extract is prepared of which the dose is 3 to 30 drops. In too large doses it produces sickness, vomiting, and depression. In bronchitis it has been used to aid expulsion of matter from the air-tubes.

Blue Cohosh (*Caulophyllum—Pappoose-root—Squaw-root—Blueberry-root*), of the order Berberidaceæ, is much used in America as a tonic and stimulant to the womb. A decoction is made with 1 oz. root to 20 ozs. water, of which 1 oz. is the dose.

Pulsatilla, the flowering herb of *Anemone Pulsatilla* or *Pasque-flower*, is used in similar circumstances. An infusion of 60 grains of the fresh plant in 3 ozs. of water is given during the day in divided doses, and a tincture is prepared of which 1 to 5 drops are given several times daily.

Of the drugs used to control bleeding from the womb, **Ergot** is the chief (see p. 835).

Sulphate of Beberine, prepared from the dried bark of the greenheart tree, *Nectandra Rodiæi*, called Bebeeru bark and imported from British Guiana, has been found useful in excessive discharge, given in 4-grain doses often repeated. It has also been employed as a substitute for quinine in neuralgia.

Section VIII.—DRUGS WHICH ACT UPON THE NERVOUS SYSTEM.

Nerve Tonics and Stimulants:
- *Their Use in the Treatment of Nervousness and Nervous Debility;*
- *Nux Vomica and Strychnine;*
- *Caffein* (coffee);
- *Phosphorus;*
- *Salts of Iron, Silver, and Zinc.*

Drugs which Lessen Sensibility and Relieve Pain and Spasm:
- *Opium and its Active Principle Morphia;*
- *Belladonna and its Active Principle Atropia;*
- *Hyoscyamus and Stramonium;*
- *Indian Hemp (Hashish—Cannabis Indica); and Calabar Bean;*
- *Hemlock* (*Conium maculatum*); *Curare or Woorari; Yellow Jasmine* (*Gelsemium*); *and Cocaine.*
- *Antipyrin and Phenacetin*—Their Use for Headache and Neuralgia.

Drugs which Procure Sleep:
- *Opium and its Preparations;*
- *Chloral Hydrate and Croton Chloral;*
- *Bromide of Potassium;*
- *Paraldehyd and Urethane;*
- *Sulphonal; Chloralamid; Chlorobrom.*

Drugs which Destroy Consciousness (Anæsthetics):
- *Chloroform and Ether;*
- *Nitrous Oxide or Laughing Gas;*
- *Bichloride of Methylene;*
- *Bichloride of Ethidene;*
- *Bromide of Ethyl; Tetrachloride of Carbon.*

If any one who turns to this section will first of all read Section V. of Part I. (p. 84), he will be able to realize what a complicated problem it is to determine by what means the nervous system may be influenced in various directions. One must remember that the nervous system is the link which binds all the other systems together, it is through it that all the organs of the body are kept working together in harmony and sympathy, it is by means of it that delicate adjustments are effected to maintain the balance of power among the bodily organs. Again, it is by means of the nervous system that the relations between the body and the external world are recognized and maintained. Finally, it is the nervous system that is the seat of those higher powers of judgment, reason, imagination, volition, which distinguish the intelligent self-conscious being, and raise him above the level of the automatic machine. Now, one can hardly ask, "What drugs act upon the nervous system?" in view of such considerations, without realizing what an enormous field a full answer to the question would cover. Take a common illustration. A person suffers from pain, say neuralgia of the face, and we shall suppose there is apparently nothing to account for it, and no appearance of anything to suggest that the person is suffering at all—no swelling, nor redness, no decaying tooth, no inflamed ear. It is a pure nerve pain, a sensory nerve is in a state of irritation or agitation for no known reason. What is desired is some remedy which shall diminish the excitability of that particular nerve, which shall soothe it, quiet it down, and so cause the pain to cease. One may apply cold to the part, or heat to the part, or an electric current to the painful nerve; but suppose all these *local* means fail, and a drug requires to be given. It is evident that it is impossible to give a medicine which will single out that one excitable nerve, and lower its sensibility without acting on any other part of the nervous system. The drug that is taken passes into the blood before it can reach the affected part, and it reaches every other part of the nervous system, every other nerve, every part of the spinal cord and brain, and indeed every other part of the body to the same extent that it reaches the part affected with pain. It may so lower the sensibility of this particular nerve that the pain ceases, but it is plain it must have some effect upon other nerves also and other parts of the nervous system. So commanding may have been the pain, that, when it ceases, the person is aware only of its cessation, and thinks of nothing but of the relief experienced, although many other marked effects may have been produced. The commonest of all remedies, in such circumstances, is opium or morphia. But that drug also acts upon the skin to cause sweating, upon mucous membranes, causing diminution of their secretion, so that there is dry mouth and throat and constipated bowels. It deranges the digestion. It acts upon the brain, at first stimulating it, so that soon the person enjoys a period of delicious exhilaration, is lively, and talkative, and imaginative, and so on. No better illustration could be found of the fact that it is impossible to limit the action of a drug, and that the exceedingly complex nature of the nervous system makes it still more difficult to define the exact nature of the action of drugs upon it. In the following classification of medicines, then, it must be understood that the drugs are classified according to the chief of the actions they produce, or according to the chief purpose for which they are employed; and it is not to be supposed that they produce the one particular effect and none other. Many of the drugs to be considered might appear under each of the different headings, producing as they do a variety of effects, according to the dose given.

Nerve Tonics and Stimulants.

The Uses of Nerve Tonics in Nervousness and Nervous Debility.—Nerve tonics and stimulants are drugs which improve the nutrition of the nervous substance, and so exercise a bracing and strengthening effect upon the nervous system. They are employed in the treatment of many nervous diseases, such diseases specially as are included under such general and vague terms as "nervousness" and "nervous depression." When, through overwork, great physical and mental strain, and so on, the general health has become impaired, the nervous system necessarily shares in the ill health. Under these circumstances certain symptoms may arise, referred to the nervous system, which need not imply any organic disease, but indicate only lessening of the usual activity of the nervous system, or some perversion of activity, simply due to the lowered nutrition of the nervous system and its exhaustion. Among such symptoms are headache, sleeplessness, irritability of temper, lessened power of mental work, and many others of a like kind. Then the symptoms which popularly are associated with "nervousness," such as unusual timidity, readiness in being startled, tendency to emotional disturbance, are common in exhausted conditions of the nervous system, for the irritability or excitability of nervous substance always rapidly becomes increased by exhaustion. Similar symptoms may arise suddenly as the result of a shock, whether physical or mental, implying perverted action of the nervous system. It is in such conditions that tonic treatment is necessary. Now, such tonic treatment will be, in the first place, general. That is, attention will require to be directed to improving the general health by appropriate food, by securing regularity of habits and regularity of the bowels, by change of air and scene, by cheerful occupation and surroundings, and by ordinary tonic remedies. All the usual remedies for improving the nutrition of the body are applicable in such cases: cod-liver oil (p. 877), iron (p. 817), arsenic (p. 822), phosphorus (p. 826), and zinc (p. 870), are those in common use; more rarely silver salts (p. 870) and copper (p. 869) have been employed. It is seldom one or other of these drugs is given alone, usually they are combined; such as, iron and arsenic, zinc and phosphorus, and almost invariably nux vomica or its active principle strychnine is added to the combination (see below). It may be added that, in the author's opinion, there are many such cases in which no remedy acts so quickly or satisfactorily as the constant galvanic current applied to the head and spine. It seems to him to be specially useful in such cases as have arisen from sudden shock, or where prolonged depressed nutrition has induced perverted action.

If we note the use of the iodide of potassium (see p. 825) in nervous diseases, we shall have grouped together the chief drugs employed to affect the nutrition of the nervous system. It is specially used for dispersing overgrowths of connective tissue which, by their pressure on the essential nerve elements, may be the cause of the nervous symptoms.

Nux Vomica and Strychnine.—The *Strychnos nux vomica*, or Koochla tree, is a tree belonging to the natural order Loganiaceæ, common in many parts of Hindostan, also found in Northern Australia, and imported from the East Indies. Its fruit is a globular, smooth, orange-coloured berry, about two inches in diameter, which contains about five seeds. It is the seeds that are used in medicine. A common name for them is *Poison-nut* or *Quaker-buttons.* Nux vomica is bitter; and all parts of the plant are so, probably also poisonous. The bark has been used to adulterate Angostura bark (see p. 840). The seeds are disc-shaped, about an inch in diameter, convex on one side or nearly flat, concave on the other, grayish in colour and silky. The chief constituents are two alkaloids, **strychnine** and **brucine**, the former of which is present to the extent of $\frac{1}{4}$ to $\frac{1}{2}$ per cent, and the latter $\frac{1}{10}$th to $\frac{1}{2}$ per cent. The **bean of St. Ignatius** is the seed of *Strychnos Ignatii*, found in the Philippine Islands. It also contains strychnine and brucine.

The preparations of nux vomica are as follows:—

	Dose.
Powdered Nux Vomica,............	2 to 5 grains.
Extract of Nux Vomica, ...	$\frac{1}{4}$ to 1 ,,
Tincture of Nux Vomica, ...	5 to 20 drops.
Strychnine, ...	$\frac{1}{30}$ to $\frac{1}{12}$ grain.
Liquor Strychniæ,..................	4 to 8 drops.
Citrate of Iron and Strychnine,	1 to 3 grains.
Citrate of Iron, Quinine, and Strychnine, ...	1 to 3 ,,
Easton's Syrup—Syrup of Iron, Quinine, and Strychnine,.......	$\frac{1}{2}$ to 1 tea-spoonful.

(Each tea-spoonful contains 1 grain phosphate of iron, 1 grain phosphate of quinine, and $\frac{1}{32}$ grain of strychnine.)

Actions and Uses.—Nux vomica and strychnine have an intensely and persistently bitter taste, and are useful as simple vegetable bitters. They are often added to stomachic tonics, such as are described on p. 841, both acid and alkaline, the tincture of nux vomica being added to the alkaline, and the liquor strychniæ to the acid tonics. The special effect of the drug is to increase markedly the excitability of the spinal cord, so that the slightest impression upon the body, communicated by eye, ear, or skin, causes by reflex action marked muscular movements. Thus a person under the influence of the drug will start violently at the slightest sound, or touch; if he sees a carriage coming towards him, as he crosses a street, his muscles may suddenly stiffen up so that he comes to a dead stop and cannot move for an instant. If excessive doses are given, the slightest impression upon any of the senses causes violent muscular spasms over the whole body, convulsions indeed; the teeth and hands are clenched, and such violent spasm of the respiratory muscles that the breathing is arrested. Death takes place by exhaustion and suffocation. These results are not sought for, of course, in medicine. It is a gentle stimulation that is desired, which makes itself evident in increased strength, greater activity, more mental power and spirit, increased sensibility of touch, sight, taste, hearing, and sense in general. The drug acts also on the bowel, increasing the peristaltic movement. Because of these various effects the drug is used as a tonic in weak digestion, and in dyspepsia as the result of excess in alcohol, the tincture of nux vomica or liquor strychniæ being the form for administration. It is also combined with purgatives to exert a tonic influence on the bowel, the extract of nux vomica being suitable, $\frac{1}{2}$ to 1 grain, with, for example, $\frac{1}{6}$ grain podophyllin and $\frac{1}{4}$ grain aloin. In many forms of nervous affection it is useful; in nervous depression in pill, 1 grain of extract with $\frac{1}{6}$ grain phosphide of zinc, or $\frac{1}{32}$ grain of phosphorus. It may be given with iron and arsenic, as 3 grains of Blaud's pill, $\frac{1}{60}$ grain of arsenious acid and $\frac{1}{2}$ grain extract of nux vomica. It is used in cases of paralysis, and in such cases small doses must be begun with, as the patient is usually easily affected by it. Specially does benefit arise from its use in paralysis following diphtheria. It tends to accumulate in the system; but persons quickly get used to the drug, so that one should begin with a small dose, which may then be gradually increased till full doses are being taken. This is always advisable, as many persons are unusually susceptible to its influence. It is employed for sexual impotence. Poisoning by strychnine is met by chloral hydrate and morphia, and strychnine is itself used as an antidote to poisoning by these latter drugs.

Caffein, the active principle of tea and coffee (p. 654), is used in medicine in doses of 1 to 5 grains. There is a citrate of caffein of which the dose is also 1 to 5 grains, and an *effervescing* citrate of caffein is prepared of which the dose is a tea-spoonful. The action of caffein, taken as such, or as coffee, is at first to stimulate the brain and spinal cord, as well as the pulse and breathing. Large doses have a poisonous effect, depressing the heart and breathing, making the pulse irregular; and it may also act as an irritant to stomach and bowels. In the lower animals it produces convulsions like those due to strychnia, and causes death. It is used in medicine as a nerve stimulant in cases of fatigue, and specially for megrim or nervous headache, for which it is very useful, but not so certain in its results as antipyrin (p. 821). Its stimulating action on digestion is marked with some people; in others it rather arrests digestion. It has also an effect upon the kidneys, exciting increased flow of urine.

Drugs which Lessen Sensibility and Relieve Pain and Spasm.

The drugs to be noted under this head are those which diminish the sensitiveness of the nerves of sense, so that they receive impressions less readily. They are dulled or blunted so to speak. Some of them, such as conium, cocaine, veratrine, aconitia, when directly applied to the skin over a painful part, will so lower the sensibility of the nerves of that part of the skin that it no longer perceives sensations of touch, or heat, or even pain. This effect is called local anæsthesia (Greek *an*, without, and *aisthēsis*, sensibility), and the substance an anæsthetic. Prolonged cold will produce such an effect; we all know how numb a part long exposed to the cold becomes, and how extreme cold blunts all the perceptions. Any substance will produce extreme cold which, when placed on the skin freely exposed to the air, rapidly evaporates, and will, therefore, act as a local anæsthetic. Many lotions applied to the skin to relieve pain are composed of such substances—chloroform, ether, &c. A spray of ether directed on a part of the skin will by its rapid evaporation cool the surface down to the freezing point, and then a deep incision may be made in the part without causing any pain. This local anæsthesia is to be distinguished from the general anæsthesia, involving loss of consciousness, produced by the inhalation of chloroform, and other drugs (see p. 906). Drugs which thus diminish the sensibility of nerves have also a quieting influence on the brain, sometimes as part of their direct action, but often merely by the soothing of pain and irritation. It is a common experience that pain will, for long periods, prevent sleep, and as soon as the pain is relieved deep sleep comes on. Substances which relieve pain are called **anodynes** (Greek *a*, without, and *odunē*, pain). Such remedies not only relieve local pain, but exert a general soothing effect upon the body, lessening the activity of various organs, and quieting disordered movement. These are, therefore, called **sedatives** (Latin *sedo*, I ease or assuage), and, because of relieving spasm, **antispasmodics**. The chief of all such drugs is opium.

Opium and Morphia.—The poppy, *Papaver somniferum*, an annual herb, growing wild in Western Asia and South-eastern Europe, is the plant from which opium is obtained, for which purpose it is extensively cultivated in Asia Minor. It has a stem 3 to 5 feet high. The fruit is in the form of the well-known **poppy heads** or **poppy capsules**, which contain the seeds. In the unripe state the wall of the capsule contains branching vessels filled with a milky juice. A few days after the petals have fallen from the flower, horizontal or vertical incisions are made into the poppy capsules with a sharp instrument, not deep enough to cut through the wall of the capsule. The milky juice exudes in tears. Next day the tears, which have changed in colour from white to brown, are scraped off, transferred to a poppy leaf, and formed into cubes. There are several varieties of opium—Turkish, Egyptian, Indian, China, Persian, &c. Turkey opium is considered the finest, and is met with in round or flattened masses from ¼ to 2 lbs. in weight, covered with the poppy leaf, and surrounded with the capsules of a species of **rumex** (dock). It has a heavy narcotic odour, and a bitter disagreeable taste.

Opium is a very complex substance. It contains the well-known alkaloids, **morphia** and **codeia**, and no less than some seventeen others, of which thebaia, papaverine, and narcotine only need be mentioned. In good Turkey opium morphia exists to the extent of 12 to 15 per cent, and codeia only to the extent of ·2 to ·4 per cent. Morphia was discovered by Sertürner, an apothecary at Eimbeck, in North Germany, in 1816. Besides these alkaloids opium contains a substance, used separately in medicine, called **meconic acid**, and also resin, gum, odorous bodies, saline substances, &c. The preparations of opium and morphia, codeia, &c., are as follows:—

Preparations of Poppy-heads—	DOSE.
Decoction of Poppy (1 oz. bruised capsules, without seeds, boiled for 10 minutes in 15 ozs. water and strained). For external use.	
Syrup of Poppy,	10 to 60 drops.

Opium Preparations—	
Powdered Opium,	½ to 1 grain.
Laudanum (Tincture of Opium),	5 to 30 drops.
Battley's Solution of Opium (Liquor Sedativus),	5 to 20 ,,
Black Drop. (1 drop is equal to 4 drops of laudanum.)	
Nepenthe. (Same as Laudanum.)	
Scotch Paregoric (Ammoniated Tincture of Opium),	30 to 60 ,,
English Paregoric, Paregoric Elixir (Camphorated Tincture of Opium),	15 to 30 ,,
Wine of Opium (1 of opium in 10 of sherry),	10 to 40 ,,
Opium Lozenge ($\frac{1}{10}$ grain extract in each),	1 to 2 lozenges.
Extract of Opium,	¼ to ½ grain.

Opium Preparations (*Continued*):

	DOSE.
Compound Opium Powder (opium, black pepper, ginger, caraway, tragacanth),	2 to 5 grains.
Confection of Opium (compound powder in syrup),	5 to 20 ,,
Pill of Lead and Opium (opium 1, acetate of lead 6, confection of roses 1),	4 to 8 ,,
Compound Soap Pill (opium 1, hard soap 4),	3 to 5 ,,
Dover's Powder (Compound Ipecacuanha Powder—opium 1, ipecacuanha 1, sulphate of potash 8),	5 to 10 ,,
Compound Kino Powder (opium 1, kino 15, cinnamon 4),	5 to 20 ,,
Aromatic Powder of Chalk with Opium (aromatic chalk powder 39, opium 1),	10 to 40 ,,
Opium and Starch Enema (see p. 874).	
Opodeldoc (tincture of opium and soap liniment, equal parts). For external use.	
Gall and Opium Ointment (p. 867).	

Morphia Preparations—

Hydrochlorate, Acetate, or Sulphate of Morphia,	$\frac{1}{16}$ to $\frac{1}{2}$ grain.
Solution of Morphia (liquor hydrochlorate of morphia, 50 drops contain $\frac{1}{2}$ grain morphia),	5 to 30 drops.
Morphia Lozenge (each contains $\frac{1}{36}$ grain morphia),	1 or 2 occasionally for cough.
Morphia and Ipecacuanha Lozenge (each contains $\frac{1}{36}$ grain morphia and $\frac{1}{12}$ grain ipecacuanha),	1 or 2.
Morphia Suppository (each contains $\frac{1}{2}$ grain morphia).	
Morphia Suppository with Soap (each contains $\frac{1}{2}$ grain morphia).	
Solution of Morphia for Hypodermic Injection (made of acetate of morphia 1 grain in 12 drops, 1 to 6 drops injected).	
Solution of Bimeconate of Morphia (same strength as laudanum),	5 to 30 drops.

Preparations of Codeia—

Codeia,	$\frac{1}{2}$ grain.
Syrup of Codeia,	1 to 2 tea-spoonfuls.

Actions and Uses of Opium.—Externally opium is used as liniment, plaster, &c., for the relief of pain, but it is doubtful whether the opium in the liniment can relieve pain acting on the unbroken skin; and it is probable that the relief is due to the warm application or to the other ingredients of the liniment. On the other hand, when the skin is broken, opium preparations are absorbed, and then relieve pain; and sometimes a blister is applied to remove the skin, and then morphia is dusted on the raw surface. When taken internally opium, morphia, &c., cause great dryness of the mouth and throat and much thirst, and quickly exert a soothing influence on the stomach and bowels. Secretion is arrested, and the movement of the bowel diminished. The result is a binding effect on the bowels, and most marked relief in inflammatory or colicky affections of the bowels. Free perspiration is caused by opium, but with this exception the activity of secreting organs is diminished. As regards its effect on the nervous system, the first effect on the brain is that of stimulation, manifesting itself in rapidity of thought, brilliance of ideas, talkativeness, exalted imagination accompanied by a feeling of exaltation, and a sense of great comfort and happiness. Or the person is inclined to lie motionless and undisturbed, while a ceaseless procession of ideas and images, of all kinds congruous and ludicrous, is passing through his mind. Following the excitement, if the dose be large enough, drowsiness comes on, and deep sleep supervenes. In very large doses it may be almost impossible to wake the person; and in poisonous doses a condition of stupor arises, the breathing becomes slow and the pulse feeble, the face is pale and with a bluish tinge, the skin clammy, the pupils of the eye are contracted to a fine point, and death occurs from stoppage of breathing.

Many people find no inconvenience from ordinary medicinal doses of opium, save that of the subsequent constipation, and dry furred tongue and much thirst. In others it produces a feeling of nausea, perhaps vomiting is induced, and great depression and headache follow after a few hours. In a few the dose of opium that would produce sleep in the ordinary individual causes restlessness and excitement and sleeplessness lasting several hours. It is quite common for even a small dose, along with considerable sweating, to produce itching of the skin all over the body, so that the person cannot rest from a desire to scratch here, there, and everywhere. Opium is one of the drugs for which tolerance is quickly established, and if it be taken regularly for any time, constantly increased doses are required to maintain the effect. The person who has developed the habit of taking opium in any of its forms suffers from intense depression and wretchedness if the usual dose is not obtained, but becomes lively and bright after the dose. The constant use gradually exerts a most degrading influence upon the nervous system, the whole moral nature becomes perverted, and a marked tendency to meanness and lying appears. Such a habit can only be broken off by the exercise of much care and patience, by the use of doses continually being diminished by imperceptibly small amounts, and by nourishing and stimulating foods.

Women are more susceptible to the action of opium than men, and *children are peculiarly susceptible, so that opium, laudanum, or any other form should never be administered to a child by an unskilled person. One case is recorded where* 1 *drop of laudanum proved fatal to a child.*

Opium and its preparations are given for the relief of pain, specially pain about stomach or bowels; in pleurisy (p. 266) and in peritonitis (p. 190) they are the chief remedies. Given in the early stage of catarrh (p. 154), or a cold in the head, in the form of Dover's powder, opium often acts like magic; and it is sometimes a proper remedy for cough (p. 284). It is used to procure sleep, but other drugs are more suitable. In painful diarrhœa it is appropriately used. It is the chief drug used in diabetes. Its quieting effects on the circulation make it sometimes useful for internal bleeding, for which purpose it is combined with acetate of lead as the lead and opium pill. Its two principal uses are, however, to relieve pain and spasm; and whenever given for one or other of these purposes it is best given as a subcutaneous injection of morphia, which acts quickly.

Morphia has less tendency to cause sickness, vomiting, sweating, and constipation than opium itself.

Codeia, chiefly used for diabetes, is much less narcotic, and is of little use for the relief of pain.

The treatment of Opium-poisoning consists of the following measures:—Empty the stomach by a dose of 20 grains of sulphate of zinc, and if that fail to act, by means of the stomach-pump. Give draughts of strong coffee, and 4 drops of the solution of atropine (see below), preferably by subcutaneous injection, every 20 minutes (every 10 minutes if it is given by subcutaneous injection) till signs of recovery appear, or till the pupils dilate. Keep the person moving about, do everything to prevent the drowsiness overcoming him by giving him no rest, and rousing him by pulling the ears, nose, hair, &c.

Apomorphia, derived from morphia, is a powerful emetic (see p. 853), but has none of the chief properties of morphia.

Belladonna and Atropia.—Belladonna, or *Atropa Belladonna*, Deadly Nightshade, Dwale, is a herbaceous perennial plant, belonging to the same natural order as the potato—Solanaceæ—and is cultivated in England. It grows 4–6 feet high, has dark-purple bell-shaped leaves (see Plate X.), and produces purplish-black berries of the size of a cherry. The leaves are employed for making the extract and tincture, and the root is used for the liniment, and to yield the active principle, **atropia,** though it is also contained in the leaves. Its chief preparations are:—

Preparations of Belladonna—	DOSE.
Extract of Belladonna,	$\frac{1}{6}$ to 1 grain.
Tincture of Belladonna,	5 to 20 drops.
Juice of Belladonna,	3 to 10 ,,
Liniment of Belladonna,	For external use.
(Made from the root with spirit and camphor added.)	
Belladonna Ointment.	
Belladonna Plaster.	

Preparations of Atropia—	
Atropia,	$\frac{1}{150}$ to $\frac{1}{80}$ grain.
Liquor Atropia,	For dropping into the eye.
Solution Sulphate of Atropia	1 to 2 drops by the mouth.
Atropia Ointment.	

Actions and Uses.—When taken internally belladonna or its active principle causes great dryness of the mouth, and consequent difficulty of swallowing and thirst. This is due to paralysis of the glands of the mouth, so that no saliva is produced. In the same way the drug paralyses the sweat glands, and causes dryness of the skin, and the mammary gland, arresting the production of milk. It causes marked dilatation of the pupil, and it abolishes the power of accommodating the eyes for objects at different distances, so that the vision of near objects is blurred and indistinct. A red rash not unlike that of scarlet fever comes out on the skin with continued use of the drug. Relaxation of the bowels is produced. It flushes the face, and this flushing with the wide black pupil, gives a look of excitement to the countenance. The head feels full and the vessels throbbing. Breathing is quickened at first, and then slowed. Belladonna diminishes the sensibility of the skin, and acts also upon the muscles, in large doses causing unsteadiness of gait. The brain is stimulated by too large doses, which cause delirium, and convulsions may occur. In poisonous doses death would be due to failure of the heart and breathing.

The purposes for which belladonna or atropia is given are thus partly quite evident. It is given to arrest excessive sweating, specially the night-sweats of phthisis. A ¼ grain of the extract in pill is useful for this purpose, and it is frequently given by injection under the skin of $\frac{1}{120}$ grain atropia. The liniment used for hands, feet, or other parts, diminishes excessive sweating in these regions. A thick paint made of extract, sufficiently thinned with glycerine, is painted over the breast to arrest the production of milk. In the same way, or as plaster or liniment, it is used to relieve pain. The liquor atropia is dropped into the eye to relieve inflammation and to dilate the pupil; and belladonna is a frequent ingredient of laxative pills. The reason of all these uses is evident from what has been said.

It is a powerful drug to relieve spasm. For this purpose it is given frequently in epilepsy (see p. 123), in whooping-cough (see p. 416), in asthma (p. 273), and may be tried in St. Vitus' dance (p. 125). To relieve pain or spasm in the bowel, or genital or urinary organs, it is frequently given as a suppository, 2 grains of the extract being in each. It is one of the best remedies for bed-wetting in children; this being often not the fault of the child, but being done without its knowledge and the result of some irritation about the bladder or urinary passages. Three to 5 drops of the tincture should be given the child at bed-time. Here it may be noted that children can tolerate the drug much better than grown-up persons, and it is well in giving it to children for any purpose to begin with quite a safe dose—2 to 3 drops, and after a day or two to begin increasing the dose by a drop or two each time till 7 or 8 drops are being given. In whooping-cough this may be given three or four times a day, *the child's eyes always being watched, and an increase of the dose being stopped whenever the pupils become very wide.* Belladonna has been used as a preventive of scarlet fever, but there seems no ground for the notion that it can prevent the infection. The use of belladonna in inflammations of the eye has been referred to on pp. 371, 372. Belladonna and atropine in their action upon the skin and pupil are the reverse of opium and morphia, and they are used as antidotes in poisoning from opium or morphia (see under Opium), and also in poisoning from Calabar bean (p. 902). The latter is used as an antidote in cases of belladonna poisoning, stimulants, coffee, caffein, being also given, and the patient being kept awake if possible.

Henbane—Hyoscyamus—is a plant (*Hyoscyamus niger*) of the same order as belladonna, the leaves of which are used in medicine. It is a biennial plant, cultivated in Britain and America. It grows 2 or 3 feet high, with pale yellow 5-leaved funnel-shaped flowers (see Plate XIII.), and its fruit is a capsule, which contains the seeds, from which an active principle, **hyoscyamine**, can be prepared. Its preparations are:—

Extract of Henbane,.......	Dose, 3 to 6 grains.
Juice of Henbane, ...	,, ½ to 1 tea-spoonful.
Tincture of Henbane or Hyoscyamus, ...	,, 15 to 60 drops.

Action and Use.—The effects of henbane resemble very much those of belladonna and stramonium. It allays spasm, and is used mainly for that purpose, being added to purgative pills to make their action easy. It is also often used to allay irritability of the bladder. It is given in nervous diseases to diminish excitement and spasm, but in large doses causes delirium like belladonna. It is useful also in affections of the lungs and air-passages, attended by much irritable cough, or in spasmodic diseases connected with these organs.

Poisoning by henbane should be met by emetics, warmth to the extremities, cold to the head, and stimulants, particularly coffee.

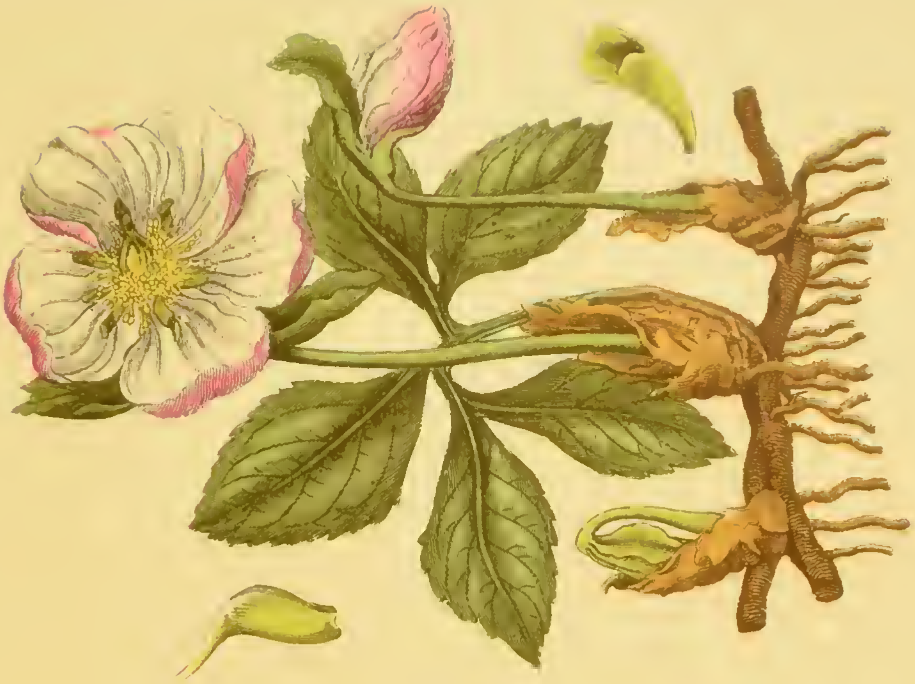
Stramonium, the leaves and seeds of *Datura Stramonium*, of the Solanaceæ order. It is also called Thorn-apple, and in the United States of America, Jamestown or Jimson weed. It grows as a weed in waste places. It is an annual about 2 feet high. Its leaves, dark green on the upper surface, are pale green below; the flowers are large, white, funnel-shaped, with five points (Plate XII.); the fruit is a capsule beset with spines and contains numerous kidney-shaped seeds. The fresh plant has a heavy narcotic disagreeable odour. A variety which resembles it very closely is *Datura tatula*, but its flowers are purple in colour. All parts of the plant yield a principle which, if not identical with atropine, is a mixture of atropine and hyoscyamine (called **daturine**). The leaves are used in the dry state for smoking; of the seeds the following preparations are made:—

Powdered Leaves,................	Dose, 1 grain.
Extract of Stramonium,........	,, ¼ to ½ grain.
Tincture of Stramonium,.......	,, 10 to 20 drops.

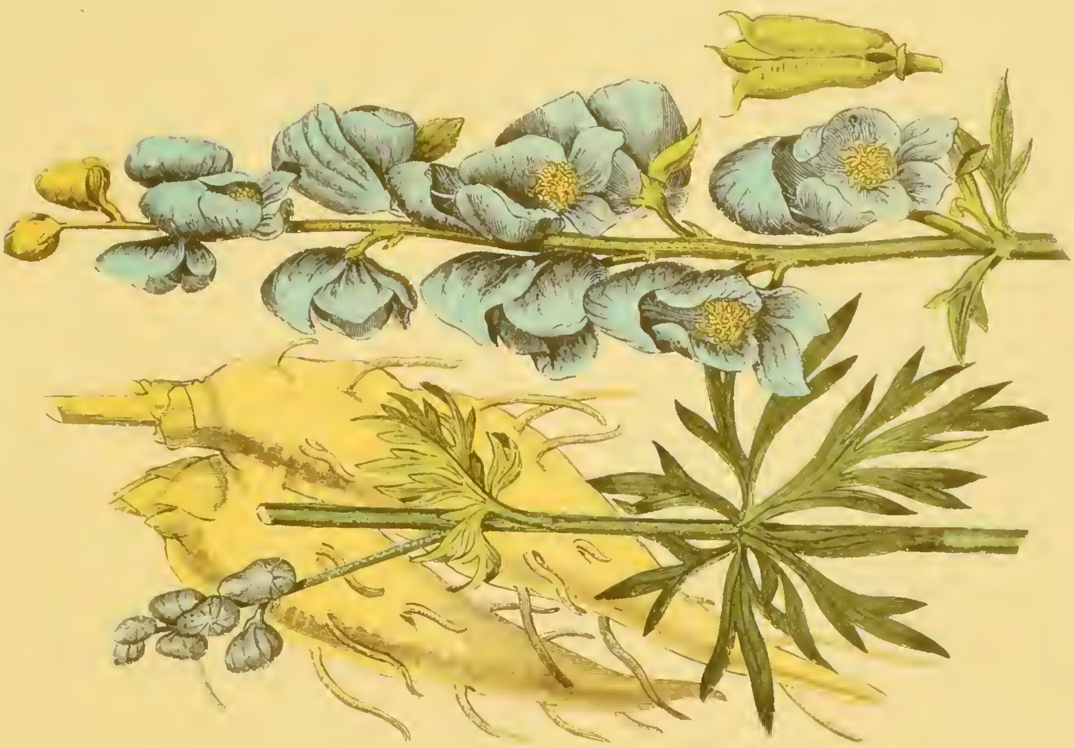
Stramonium, belladonna, and henbane cannot be distinguished in their effects from one another when given in corresponding doses, as is to be expected, since their active principles are

COMMON POISONOUS PLANTS.

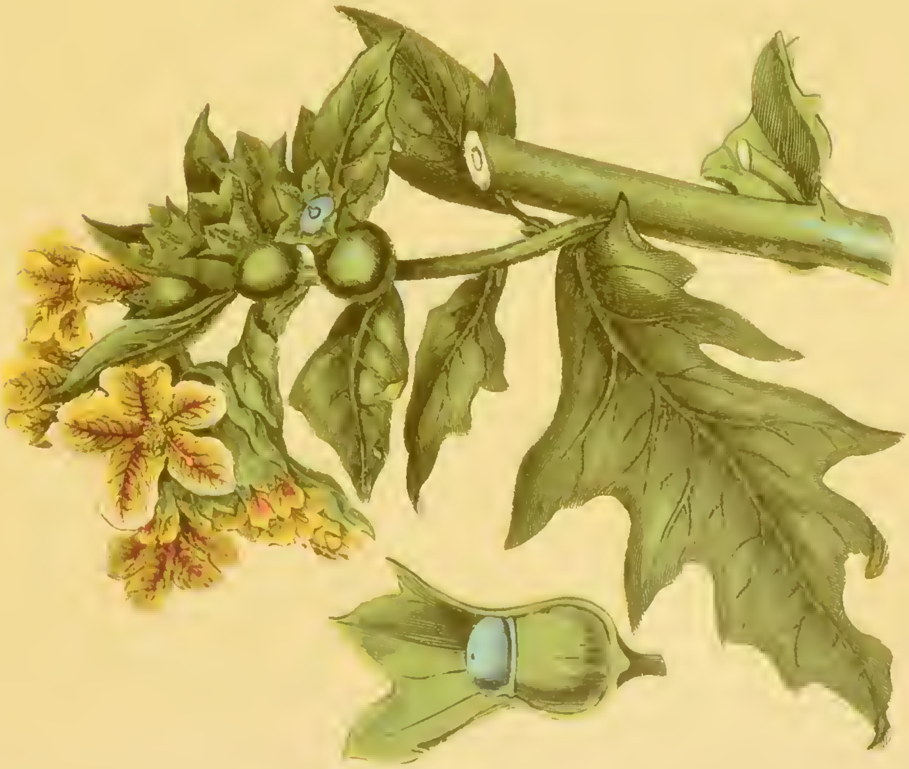
Plate XIII



BLACK HELLEBORE or CHRISTMAS ROSE
(Helleborus Niger)



COMMON WOLF'S BANE or MONK'S HOOD
(Aconitum Napellus)



COMMON or BLACK HENBANE
(Hyoscyamus Niger)

practically identical. Stramonium, like belladonna, produces dryness of the throat, dilatation of the pupils of the eye, delirium, and, in poisonous doses, convulsions and death. It is specially employed to relieve spasm of the respiratory organs, and its main use is for asthma, for which the leaves are smoked like tobacco (p. 273). About 15 grains of dried leaves may be smoked at once, or half that quantity of the fibres of the dried root mixed with sage-leaves or tobacco, in a pipe or cigarette; or tobacco steeped in a strong decoction of stramonium may be used, or cigars similarly treated. Opium is the antidote to poisoning by this drug, and especially morphia given by injection under the skin. In one case 15 grains of hydrochlorate of morphia were required, *given by the mouth*, before the patient was out of danger.

Tobacco.—The tobacco plant (*Nicotiana tabacum*) belongs to the same order as belladonna, henbane, and stramonium. It is indigenous to tropical America. It is an annual plant 4 to 6 feet in height, with a stout heavy stem, with numerous dull-green leaves, those near the root being often 2 feet long and 4 or 5 inches broad. The flowers are rose-coloured, funnel-shaped, with united petals 5-pointed. The fruit is a capsule containing numerous small kidney-shaped seeds. The plant was brought, it is believed, from Virginia. The generic name "Nicotiana," was bestowed on it in honour of Jean Nicot, ambassador of Francis II. in Portugal, "who brought some tobacco from Lisbon and presented it to Catherine de Medicis, as an herb possessing valuable properties; hence also it has been termed **queen's herb**. By some persons the name tobacco is said to have been given to the plant by the Spaniards, who took it from Tobaco, a province of Yucatan, where they first found it and learned its use; others derive it from the island of Tobago; but Humboldt asserts that the word tobacco (tabacco), like the word savannah, maize, cacique, maguey (agave), and manatee, belongs to the ancient language of Hayti, or Saint Domingo; and that it does not properly denote the herb, but the tube through which the smoke is inhaled." The same authority asserts that Europe received the first tobacco-seeds from Yucatan in 1559, and that its cultivation in Europe preceded that of the potato by 120 or 140 years. When Raleigh brought it to England in 1586, it was already largely cultivated in Portugal.

When tobacco is burned it yields about 14 to 18·5 per cent of ash, consisting of salts of potash, lime, and ammonia. It contains besides albumin, gum, resin, extractives, and a powerful principle **nicotine**, and a volatile oil **nicotianin**. Nicotine is a colourless, oily-looking fluid, with an irritating tobacco-like odour and an acrid taste, and was discovered by Posselt and Reimann in 1828. Of this active principle dried tobacco-leaves contain from 2 to 8 and occasionally as high as 11 per cent. This is present in all parts of the plant and is present also in tobacco-smoke. But it would appear that by the burning process much, if not all, of the nicotine disappears and other compounds are formed, whose character varies according as the air has a more or less free access to the burning tobacco. When burned in a pipe a substance called **pyridine** is chiefly formed, but when burned in cigars another substance is formed called **collidine**, which is far less active than pyridine. In the United States an oil of tobacco is prepared by dry distillation of coarsely-powdered tobacco, a wine of tobacco by exhausting 120 grains of tobacco with 4 ounces of sherry, and an ointment made of an aqueous extract of ½ oz. of tobacco and 8 oz. lard; an enema of tobacco is made with 20 grains of tobacco infused in 8 oz. boiling water for half an hour. It used to be employed to produce depression and relaxation in strangulated hernia, and in dislocation, the great muscular depression permitting easy reduction of the dislocation, and also for obstinate constipation and retention of urine; but chloroform has taken its place in the former circumstances, and other substances in the latter. Tobacco acts as an irritant to stomach and bowels, producing copious flow of saliva, sickness, vomiting, colic, and purging. Smoking may produce like effects, the use of snuff, or the application of the leaf to the skin. That is why tobacco is found to relax the bowels, while at the same time, by producing a catarrhal condition, it may give rise to indigestion. The effect of nicotine on the heart is to slow it at first; the beat is then quickened and finally becomes slow and weak, while the face is pale, and a tendency to faint arises. Small doses first slightly excite the nervous system; larger ones cause depression, ending in great muscular tremulousness, convulsions and paralysis; and death is caused by paralysis of the respiratory muscles.

Tobacco used to be employed for itch, but the risk of poisoning was considerable; the smoke was used for asthma and the enema to produce muscular weakness. It is not now employed for such purposes. As to the effects of tobacco-smoking, they are both mildly stimulating and soothing to the nervous system, and in moderation tobacco-smoking cannot be said to be injurious to many people, though some are so susceptible to its influence that the smallest amount is positively injurious. On the other hand excessive tobacco-smoking is undoubtedly on the increase, and its evil effects are perfectly recognizable and well marked. Apart from furred tongue, dryness and irritability of the throat, there is a bad effect on the stomach and heart. Irritable dyspepsia arises, indigestion with severe heart-burn is common, and palpitation of the heart of a particular kind (smoker's heart). This disappears if smoking is given up for a time. One of the effects of excess in tobacco which is most familiar to the author is dimness of vision, due to an effect upon the nervous structures of the eye, which is called **tobacco amblyopia** or tobacco blindness. In the author's experience it is very common when a smoker consumes between 3 and 4 ounces of tobacco per week. Of course many escape, it is indeed only the comparatively few that go to excess who suffer from loss of sight, yet one never can tell what smoker to excess will escape and who will be caught. The author has not found such tobacco blindness arising if the smoker restricted his supply to 2 oz. per week, though the digestive and heart symptoms may arise from even less. The only remedy for such a state of things is remorselessly and resolutely to cut off the tobacco.

An emetic, followed by stimulants, is the appropriate treatment for poisoning by tobacco.

Indian Hemp, the flowering tops of the female plant of *Cannabis sativa*, grown in the East Indies, which are pressed together in masses and held so by the resin adhering to the fresh tops. One form of it used in India is called by the Arabs **hashish**, by the Indians **bhang** or **siddhi**; the form sent to market is called **gunjah** or **ganga** and **guaza**; while to the resin itself, which may be scraped off the tops, the name **charas** or **churrus** is given. Indian hemp contains a resin called **cannabin** and a volatile oil, **cannaben**.

Its preparations are:—

Extract of Indian Hemp, ...	Dose, $\frac{1}{4}$ to 1 grain.
Tincture of Indian Hemp,.....	,, 5 to 10 drops.

Indian hemp produces a species of intoxication, in which the person's ideas of the natural relations of things become perverted. The patient may, in his disordered imagination, pass through the experience of days and weeks all in a few minutes; his own personality may become of enormously increased importance; faint whispers seem to his ear tones of thunder; and all sorts of fantastic pictures appear to his mind. With different individuals, however, various effects may arise. Some may be made only drowsy and depressed. Sleep and stupor follow the intoxication, pain and spasm being diminished. Coffee and tobacco increase the effects of the drug. In an instance, occurring in the author's experience, the person, who had taken of his own accord $\frac{1}{4}$ grain of extract in pill for headache, felt no particular effects till $1\frac{1}{2}$ hours after, when, having taken dinner, he sat down to enjoy a cigar. The tobacco quickened the influence of the drug, and when seen the person was walking up and down his room without cessation, evidently suffering from acute depression. He complained of a great feeling of anxiety, and intense restlessness which would not permit him to stop his walk for an instant. At the same time his limbs felt like lead, but he walked without difficulty or unsteadiness. Every now and again a wave of depression would pass over him, during which, though spoken to, he would not utter a word. Shortly that would pass off, and then he would talk freely describing his sensations, until another wave of depression would suddenly cause his tongue to cease though his feet kept their restless pacing to and fro. Of course, at no time was he in danger. Someone had advised him to take an emetic of mustard and water, and of that he took two tumblersful, but without effect, the drug having so quieted the stomach. Hot stimulants would have been a more appropriate remedy. Indian hemp is used to relieve pain and to procure sleep, when opium is likely to disagree. It is in cases of painful monthly illness, and in recurring sick headache, that it has been specially used. It has been lauded in the treatment of tetanus—lock-jaw. In India it is often used by being smoked in a pipe.

Calabar Bean, ordeal bean, the seed of the *Physostigma venenosum*, a woody climber somewhat resembling the Spanish bean or scarlet runner, growing near the mouths of the Niger and Old Calabar river in Western Africa. It contains an active principle, called **physostigmin**, or more commonly **eserin**. Its preparations are as follows:—

Powdered Calabar Bean,......	Dose, 1 grain.
Extract of Calabar Bean,.....	,, $\frac{1}{16}$ to $\frac{1}{4}$ grain.
Tincture of Calabar Bean,....	,, 10 drops.
Eserin,..............................	,, $\frac{1}{65}$ to $\frac{1}{20}$ grain.

Calabar bean acts chiefly upon the spinal cord, the excitability of which it greatly reduces and in large doses abolishes. The result is a loss of power over voluntary movements, and diminished sensibility of the skin. Besides these symptoms there are intense prostration, pallor, weak pulse, shortness of breath, and marked contraction of the pupil of the eye. Consciousness is not impaired; sickness, vomiting, diarrhœa, and much perspiration may occur. Poisonous doses cause death by paralysis of breathing. One of the chief uses of the drug is in tetanus (lock-jaw, p. 126), for which it has been shown to be one of the most useful drugs. It is recommended to be given in doses of $\frac{1}{3}$ grain of extract every quarter of an hour till the spasms cease; the action of the drug should be maintained till the tendency to recurrence of the spasm ceases. Another chief use of the drug is in the form of a solution of eserin, dropped into the eye to contract the pupil. For this purpose it is used in glaucoma (see p. 375), though an operation is the chief treatment of this affection. The drug also is antagonistic to belladonna, in poisoning by which it could be used; and, of course, belladonna, or its active principle atropia, would be an appropriate remedy in poisoning from Calabar bean, coffee and other stimulants being also given.

Hemlock, the Poison or Spotted Hemlock, or *Conium maculatum* (Plate XI.), a plant of the natural order Umbelliferæ, which grows wild in Britain. The leaves are gathered when the fruit begins to form, and the full-grown fruit is also gathered and dried for use in medicine. Both leaves and fruit contain an active principle, **conia**. Its preparations are:—

Powdered Hemlock Leaf,	Dose, 2 to 8 grains.
Green Extract of Hemlock,	,, 2 to 6 ,,
Alcoholic Extract of Hemlock,	,, 2 grains.
Fluid Extract of Hemlock (American),	,, 15 drops.
Compound Pill of Hemlock,	,, 5 to 10 grains.
Juice of Hemlock (expressed from the fresh leaves with added spirit),	,, 30 drops to 2 tea-spoonfuls.
Tincture of Hemlock (made *from the fruit*),	,, 20 drops to 1 tea-spoonful.
Vapour of Hemlock (see p. 885).	

The chief action of hemlock is upon the nerve-endings in the voluntary muscles, which they paralyse, so that weakness of the legs and a staggering gait, ending in complete loss of power, are the chief symptoms of large doses. Sensation is not affected, nor the mental functions. The eyelids fall, the pupils dilate, the hands and feet are cold, speech is slow and difficult, and the voice hoarse by relaxation of muscles; and in fatal doses death is caused by paralysis of breathing, and is sometimes accompanied by convulsions. Its chief use is for the relief of cough as vapour, and for St. Vitus' dance.

The treatment of poisoning by conium is an emetic, hot stimulants, and the external application of heat.

The Lesser Hemlock, Fool's Parsley (*Æthusa cynapium*, Plate XI.), was supposed to be a poisonous plant, but recent investigations have shown it not to be in any degree poisonous, the error having arisen from its strong resemblance to conium.

Curare, Woorare, Urari, the South American arrow-poison, is a mixture of various substances, the chief of which is a variety of Strychnos. Its chief effect is to paralyse the nerve-endings in muscle, in large doses the sensory nerves also, and later the spinal marrow. Great relaxation of the muscle is, therefore, produced, the eyelids sharing in the paralysis so that the eyes cannot be opened, and there is complete loss of power over the body, death occurring by paralysis of breathing. The poison is rapidly removed from the body by the kidneys, and if breathing be artifically maintained recovery is likely to occur. The drug has been used chiefly in the treatment of spasmodic diseases, such as lock-jaw, hydrophobia, epilepsy, St. Vitus' dance. In hydrophobia and tetanus it has been given by injection under the skin, $\frac{1}{10}$ grain in watery solution.

Yellow Jasmine, the dried root-stock and rootlets of *Gelsemium sempervirens*, from which the following preparations are made:—

Alcoholic Extract of Gelsemium,	Dose, $\frac{1}{2}$ to 2 grains.
Fluid Extract of Gelsemium (American),	,, 5 to 20 drops.
Tincture of Gelsemium (British Formula),	,, 5 to 20 ,,
Tincture of Gelsemium (American Formula),	,, $\frac{1}{2}$ to 2 tea-spoonfuls.

This is a drug which produces blunting of general sensibility, and in large doses languor, dizziness, impaired sight, drooping eyelids, muscular relaxation, feeble irregular pulse, and death through arrest of breathing. It has been much used in America and for many diseases. That in which undoubted benefit has been obtained from it is neuralgia of the face, specially that due to cold or rheumatism. It is a drug about which much care needs to be exercised, small doses often producing alarming symptoms. Numerous cases of death from its use have been recorded in America. Morphia, injected under the skin, is said to be the proper remedy, after the stomach has been emptied by an emetic. Stimulants, ammonia, coffee, and whisky should be freely administered, and heat applied to the body.

Cocaine, the acting principle of *Cuca* or *Coca*, described at p. 663. Its preparations are as follows:—

	DOSE.
Coca Wine,..............................	a wine-glassful.
Liquid Extract of Coca, ...	1 to 4 tea-spoonfuls.
Fluid Extract of Coca (American),	$\frac{1}{2}$ to 2 ,,
Extract of the Green Coca Leaves,	5 to 15 grains.
Cocaine, ...	$\frac{1}{5}$ to $\frac{1}{2}$ grain.

The effects of coca have been described on p. 663. The wine and liquid extracts are used for their tonic and stimulating effects, in fatigue, and to produce sleep. The active principle, cocaine, when applied to the skin or mucous membrane, destroys sensibility for a time. Applied to the tongue or mouth and throat it completely blunts the sensibility, so that taste cannot be felt. A drop or two of a 4 per cent solution let fall into the eye abolishes sensation, so that simple operations can be performed without pain. Injected into the gum round a tooth it will so lower the sensibility that the tooth can be extracted without pain. It is for such purposes it is chiefly employed. It can produce poisonous effects in too large doses. Large doses cause a feeling of fulness in the head, great restlessness, giddiness, headache, and even delirium; and death results from stoppage of breathing. Stimulants are the appropriate remedy.

Among other remedies for nerve pain are **Antipyrin,** noted on p. 821, and **Phenacetin.** The latter drug is like the former used to reduce temperature in fevers, being given in doses of 8 grains. Both relieve pain, and are valuable in nervous headache and neuralgia.

Drugs which Procure Sleep.

Drugs which procure sleep are called **hypnotics** (Greek *hupnos*, sleep), or soporifics (Latin *sopor*, sleep, and *facio*, I make), terms applied to remedies which calm and soothe the nervous system so that sleep naturally ensues, without being absolutely compelled, as it were. The drugs which act much more strongly and compel sleep, which is then of the nature of a stupor, are called **narcotics,** from Greek *narke*, deep sleep. One and the same drug may be used in both ways, that is to say, a small dose of the drug may be sufficient to procure sleep simply by so relieving pain or restlessness that sleep is not prevented; while it may also be given in a large dose to produce a narcotic effect. Such a drug is opium with its preparations. When a person is under its full influence, vigorous and, in ordinary circumstances, painful impressions may be made upon his body without producing the slightest response. It has been already sufficiently described on p. 897.

Chloral Hydrate is formed by passing chlorine gas through absolute alcohol. It was discovered by Liebig in 1832. It is in the form of colourless crystals of a peculiarly pungent smell and taste.

	DOSE.
Chloral Hydrate, ...	5 to 20 grains.
Syrup of Chloral Hydrate,......	$\frac{1}{2}$ to 2 tea-spoonfuls.

(10 grains in each tea-spoonful.)

Actions and Use.—Chloral hydrate is an irritant to the skin, has a hot burning taste, and applied to a raw surface acts as a powerful irritant. A solution of 5 grains to an ounce of water acts as an antiseptic, preventing decomposition. When it is given internally in doses of 20 grains or thereby it quickly induces sleep, of a natural and refreshing character, the awaking from which is unattended by the headache, sickness, confusion, or feeling of stupidity that usually follows sleep procured by opium. In larger doses the sleep is deeper and more prolonged; the person can with difficulty be awakened from it; pain is abolished; breathing becomes slow and shallow; and the pulse, quickened at first, is afterwards slowed; the pupils are much contracted; and there is complete muscular relaxation. This last effect, with the abolition of pain, is due to the action of the drug upon the spinal marrow. The result of poisonous doses is a great fall in bodily heat and paralysis of the heart. In animals death by chloral poisoning has been prevented by means which maintain the bodily heat, and the treatment of chloral poisoning consists in the use of warm blankets, hot bottles, hot stimulants such as hot coffee, hot toddy, &c. The taste for chloral hydrate is apt to grow upon one so that its use cannot readily be given up. When taken habitually, it is apt to produce irritability of the stomach, nervous irritability also, and skin eruptions. With constant use larger doses require to be taken; and persons who are accustomed to its use are very apt some day, owing to their familiarity with the drug, to take an overdose, a very slight increase of an accustomed dose being sometimes sufficient to cause death. Chloral hydrate is chiefly used to procure sleep, when it is difficult to obtain owing to nervous excitement, as the result of overstrain or worry, in feverish diseases, and in conditions of delirium and insanity, and specially in delirium tremens. It is not nearly so useful for the relief of pain. No drug can compare with opium for such a purpose; and it is useless to use it for neuralgia. It is useful in convulsions, and may be used in cases of convulsions in children, to whom in proper doses it may be given with comparative safety, while opium is for them a most dangerous drug. The dose of chloral for children is 1 grain for each year of the child's age. It is beneficial in sea-sickness. It is the antidote to poisoning by strychnine.

Chloral with Camphor, or Camphorated Chloral, is a mixture of equal parts of chloral hydrate and camphor rubbed together in a mortar. It is a colourless liquid of syrupy consistence. It is used for painting over painful parts in neuralgia and rheumatism.

Croton Chloral Hydrate, or Butyl Chloral Hydrate, is a drug which acts similarly to chloral hydrate. It is made by passing chlorine gas through, not alcohol, but acetic aldehyd. Its dose is from 2 to 15 grains. It is said to act less quickly and surely than chloral hydrate, but to depress the heart less. In particular it lowers the sensibility of nerves of the skin, specially of the sensory nerve of the face. On this account it has been recommended for neuralgia of the face, and tic douloureux along with gelsemium (p. 903); and it has proved useful in cases of nervous headache and painful monthly illness.

Bromal Hydrate is a drug prepared like chloral hydrate, the vapour of bromine being substituted for chlorine. It is very irritating, and cannot be taken internally unless largely diluted, because of burning in the throat, and vomiting and diarrhœa arising owing to irritation of gullet, stomach, and bowels. It is poisonous in smaller doses than chloral, and there is no good reason why it should be used at all.

Bromides of Potassium, Sodium, and Ammonium.—These are salts of bromine with potash, sodium, and ammonium. Bromine is one of the elements, a brownish-red liquid, readily converted into vapour, orange-red in colour, and intensely irritating to throat and eyes. It is obtained from sea-water. The bromides of potash, soda, and ammonia are all used for their soothing effects upon the nervous system. They diminish the excitability of all sensory nerves, acting also upon the spinal cord and brain. The activity of the brain they greatly lessen, and are specially valuable on this account in getting rid of sleeplessness due to restlessness and excitement. In such cases a dose of 10 to 15 grains, taken a short time before going to bed, may be enough to quiet down the brain sufficiently to cause natural sleep. They are particularly useful in delirium tremens, and may for this be combined with chloral hydrate. The bromide of potassium is the most common drug for convulsive diseases, such as epilepsy and child-crowing. It relieves sickness in pregnancy; and the delusions that occasionally trouble pregnant women in the later months are commonly removed by it. With prolonged use of the bromides a condition called **bromism** arises, one of whose symptoms is an eruption of pustules, specially on the face, as well as unsteady gait, impaired memory, and other symptoms of dulled mental power. Bromide of sodium has the same uses as the bromide of potassium, but is less depressing; of the bromide of ammonium the same may be said. It is commonly used with belladonna for whooping-cough. The great advantage of the bromides is safety in their administration. They are most valuable in children's diseases, for which they need never be given in less than 5-grain doses. In convulsions they are the invariable remedy, and they may be given at times when children are apt to be peculiarly restless and irritable, such as the period of teething. At the same time, while they are thus safe, they are never to be given indiscriminately and for the mere sake of saving mother or nurse some little trouble by inducing sleep in the child.

Monobromated Camphor is a compound of camphor and bromine, which produces sleep like the bromides. It has been recommended for that purpose in nervous sleeplessness, in St. Vitus' dance, and in hysteria, and it has been used in epilepsy. Its dose is 2 to 10 grains, and it is given in pill.

Paraldehyd.—Aldehyd is formed by the oxidation of alcohol, a stage before the production of acetic acid, into which pure aldehyd readily passes. Paraldehyd is obtained from aldehyd by treatment with dilute sulphuric or nitric acid. It is at ordinary temperatures a colourless liquid, but becomes crystallized if cooled below 50° Fahrenheit. It has a peculiar ethereal odour. Given in doses varying from 15 to

60 drops, it produces sleep for several hours, leaving behind no headache, digestive disturbance, or other unpleasant symptom. It does not depress the heart. It increases the flow of urine, but has no effect on the skin. It is in sleeplessness, both that due to nervous conditions, and that due to acute disease, and in mania and delirium, particularly delirium from drink, that it is most serviceable. It may be given in 30-drop doses, repeated thrice, at intervals of half an hour, if required. If it fails then to act it need not be continued.

Urethane, or Ethyl Carbamate, is another recent remedy for sleeplessness, which, while producing the tranquil effects of chloral hydrate, has none of its depressing effects upon the heart and respiration. It quiets the brain excited by worry or overwork, and puts it in a condition for natural sleep. Its dose is 4 to 8 grains, repeated every half hour, for 4 or 5 times, till sleep is obtained, or 15 to 30 grains given in one dose; but it is best given in small doses frequently repeated, as vomiting is apt to occur after a large dose. It is said to be an antidote to strychnia poisoning.

Sulphonal is the most recent of all drugs for the production of sleep. It was prepared by Professor E. Baumann, of the University of Freiburg, and described by him in 1888. In doses of from 16 to 60 grains, it produces in from $\frac{1}{2}$ to 2 hours a quiet natural sleep, from which the patient awakens refreshed in from 5 to 8 hours, without any feeling that would suggest that the sleep had been anything but natural. It is free from the disagreeable effects of opium, and the heart-weakening produced by chloral. In simple sleeplessness, in the sleeplessness of fevers, in sleeplessness in lunatics, &c., it may be given with good results and without fear. The author has, from his own experience, formed a high opinion of its value. He finds 15 grains, given at bed-time, to be generally successful in obtaining an uninterrupted sleep for fully 8 hours, with no subsequent bad effects. In his opinion it is far superior to urethane and paraldehyd, from which he failed to get any very satisfactory results in the limited number of cases in which he employed them, while sulphonal yielded immediate benefit.

Chloralamid is another of the newer remedies. It is obtained from chloral hydrate. It occurs in colourless crystals with a faintly bitter taste. Its use is advocated in sleeplessness, in the course of nervous and heart affections, and enteric fever. It is given in 20-grain doses in a little spirit and water, or in a slightly acid solution.

Chlorobrom is a mixture of chloralamid and bromide of potassium, of each 30 grains in one ounce of water. The dose is one table-spoonful in water. It is recommended in sleeplessness, specially of nervous origin. It is highly praised as a preventive of sea-sickness. A table-spoonful should be taken on going on board ship, and the person should at once go to his berth and lie down. In an hour a second similar dose may be taken, and in another hour a third dose if necessary.

Drugs which Destroy Consciousness: Anæsthetics.

We have already noted in this section several drugs which, locally applied, relieve pain by lessening sensibility, such as cocaine, which are, therefore, rightly enough called **local anæsthetics**. But in the following paragraphs we must consider a number of drugs which produce a diminution of sensibility all over the body, and not merely at one part. Then we have seen that opium, chloral hydrate, Indian hemp, &c., diminish sensibility and relieve pain, and are capable of producing an anæsthetic influence, and abolishing consciousness. They do this, however, as their final effect, the loss of consciousness coming as the crowning effect of a large dose, and such doses as are attended by dangerous weakening of the heart and breathing before the loss of consciousness is obtained. The drugs we are about to consider, on the other hand, suspend consciousness almost to begin with, only later and with continued administration acting injuriously upon the nerve-regulating apparatus of heart and breathing. Where, then, it is a question first and foremost of abolishing consciousness for the removal of pain, or preparatory to the performance of a painful operation, these manifestly are the drugs to be employed. The chief of them are chloroform and ether.

Chloroform is obtained from alcohol by the action of chlorinated lime, the production of chloral being one of the stages in the process. It is a compound of carbon, hydrogen, and chlorine, one combining weight of each of the former to three combining weights of the latter; and it is represented by the formula $CHCl_3$. It is a limpid colourless liquid, of an agreeable ethereal smell, and with a sweet hot taste. It mixes readily with spirit, olive-oil, and turpentine, but requires much water for solution. Its dose and preparations are as follows:—

	DOSE.
Chloroform,	3 to 10 drops.
Chloroform Water (1 of chloroform, 200 of water),	½ to 2 fluid ounces.
Spirit of Chloroform—Chloric Ether,	10 to 60 drops.
Compound Tincture of Chloroform,	10 to 60 ,,
(Chloroform 2, spirit 8, compound tincture of cardamoms 10.)	
Chloroform Mixture (American),	1 to 2 table-spoonfuls.
(Chloroform 8, camphor 2, fresh yolk of egg 10, water 80.)	
Liniment of Chloroform (equal parts of chloroform and liniment of camphor).	For external use.

Actions and Uses.—Chloroform has two different effects when applied to the skin, according as the skin is covered over when the chloroform has been put on or left uncovered. In the latter case it quickly evaporates, cools the skin, diminishes sensibility, and reduces pain; in the former case it acts as an irritant, reddens the skin, producing heat and pain and even blistering, but ends by diminishing the sensibility of the part. It is, therefore, used in various circumstances as a liniment for neuralgia, lumbago, and for application to a painful tooth, &c. When taken by the mouth it produces a hot burning sensation in the mouth, gullet, and stomach; and, when it reaches the stomach, acts in the first instance as a stimulant, expelling wind and relieving griping. For this purpose the compound tincture or the mixture of the American Pharmacopeia is the most useful preparation. In large doses it will irritate the stomach and bowels, causing at first pain, vomiting, and purging, but, when absorbed into the blood, it will, by diminishing sensibility, cause the pain to cease; and if the dose has been large enough will cause unconsciousness. Apart from its use as a liniment and for flatulence, it is given directly for its effects upon consciousness; and for that purpose is given as vapour. The person to whom it is to be administered lies upon a bed or couch, all tight articles of clothing, especially about the neck and waist, being removed; the chloroform is dropped upon a folded towel, which is held above the mouth and nostrils, *not touching them*, a space being between the face and the towel, so that air readily passes in to be inhaled. It is not thus pure vapour of chloroform that is inhaled. Very far from that is desired. Indeed, the vapour of the chloroform is, when undiluted, irritating to the air-passages just at first, and could not be respired. When a patient is being put under chloroform, if the towel be held too close to the mouth so that the vapour is too strong, arrest of breathing and spasmodic cough are produced from the irritating effects. The air, therefore, requires to be charged with only a small percentage of chloroform vapour, and this being inhaled gradually blunts the sensibility of the respiratory passages, so that soon a stronger charge can be inhaled, and the towel can be gradually approached. Indeed, throughout the whole procedure of the administration of chloroform, success and freedom from danger depend upon the proportion which the pure atmospheric air and the vapour of chloroform inhaled hold to one another, excess of the chloroform vapour tending to the production of symptoms of poisoning by arrest of breathing or stoppage of the heart, while if the chloroform is properly administered unconsciousness can be maintained for prolonged periods without danger. When chloroform is inhaled thus the first effects are stimulating to the brain. It is the brain that is at the very outset affected. Noises are heard in the ears, feeling and imagination are exalted. Thereafter excitement becomes pronounced, and the patient begins to talk loudly and rapidly or to sing, while gesticulation and often violent struggling ensues, till the chloroform begins to act more powerfully, when the muscles become weakened, the movements are irregular, feeble, and easily controlled, and complete relaxation results. At this period there is complete unconsciousness. Some amount of voluntary power may remain, so that the reflex starting of a limb might occur, if a painful impression were made upon it. But with a little longer inhalation this too ceases, and now any operation can be undertaken without the slightest impression being produced on the patient. The nerve centres which control the breathing and the action of the heart are in full activity. In the previous stage both are highly stimulated, so that the pulse is quick, very quick, and the breathing is also more rapid. But as the chloroform acts the speed diminishes, till, when the appropriate time for operation is reached, the pulse should be strong, full, steady, and at a usual rate of rapidity, and the breathing is regular and deep. Indeed, one accustomed to administer chloroform can gauge by the pulse the proper amount to administer. If the administration be continued beyond the stage now reached, paralysis of the heart and breathing would arise, the heart beating feebly and irregularly, or suddenly ceasing altogether, and breathing becoming irregular and feeble or arrested. Therefore, as soon as the proper stage has been reached, the inhalation is suspended by removal of the cloth from the neighbourhood of the face, and the patient breathes pure air. As soon as a return to consciousness is indicated by some slight movement, the inhalation is resumed, and so on. Chloroform thus acts upon the highest nerve centres first, abolishing control, then arresting all the mental functions, subsequently destroying sensibility and power of motion, and only, last of all, paralysing the nerve functions which preside over the circulation and breathing. Many people take chloroform with perfect quietness, and without making the least sound or struggle from beginning to end of its administration.

Death by chloroform is most commonly due to stoppage of breathing. It is to be met by all measures which stimulate the breathing—slapping the chest with towels wet with cold water, artificial respiration, &c., care being taken that abundance of pure air is being driven on to the patient from open windows, &c. Breathing may stop because of mechanical obstruction by the falling back of the tongue. This is met by pulling the chin forwards by the fingers hooked under it, and by catching the tongue and pulling it forwards. If the heart stop suddenly, indicated by pallor of lips and face, the patient's head should be quickly lowered, friction and hot sponges used over the heart, and artificial respiration carried on. Sickness is frequent during the administration of chloroform, and is best avoided by the patient having no solid food for several hours before administration; a cup of beef-tea two or three hours before is valuable. After the administration the patient should be kept lying flat and quiet for two hours before any food is given, which may then be cold beef-tea, jellies, &c. After twelve hours, ordinary food, if otherwise suitable, is returned to.

Chloroform must never be given by any unskilled person; and it would be the height of folly for a patient to attempt to administer it to himself.

Chloroform is given not only for the production of unconsciousness to permit of surgical operations, but also for the relief of pain such as accompanies the passage of a calculus or gall stone, for the arrest of convulsions in either adults or children, and in child-bearing. In the latter case it is not necessary to push the administration so far as for surgical operation, unless the employment of instrumental means of delivery is required.

It is generally supposed that any affection of the heart would be an indication against the administration of chloroform. This is not so. It suggests, of course, the necessity of great care in its administration. But if any heart affection exists, the incomplete administration of chloroform during an operation would be attended by more risk than its complete administration. The necessity exists, in such cases, of guarding the heart from shock, and this is best done by producing complete anæsthesia. Many of the deaths during chloroform inhalation have apparently occurred because enough had not been given, and the impression made by the operation upon sensory nerves had by reflex action caused sudden arrest of the heart.

Ether.—Sulphuric ether is prepared from alcohol by distillation with sulphuric acid. It is a compound of carbon, hydrogen, and oxygen, and has the formula $C_4H_{10}O$. It is a colourless, very volatile liquid; and highly inflammable.

	DOSE.
Ether,..	20 to 60 drops.
Spirit of Ether (Hoffmann's Anodyne),	30 to 60 ,,

Ether evaporates with great rapidity, and it is, on that account, applied to the skin as a spray either to relieve pain by its cooling effect, or by freezing the part to permit of incisions being made without causing pain. As with chloroform, if it be applied under cover it reddens and blisters the skin. It is used, like chloroform, specially in the form of spirit of ether, as a stimulant to the stomach to expel wind and relieve spasm. At the same time it stimulates the heart, and is employed in palpitation, faintness, and depression because of its rapid action. In hysterical flatulence it is very useful, and in spasmodic cough and asthma. Ether is employed in exactly the same way as chloroform to abolish consciousness and permit surgical operations. It has advantages over chloroform for this purpose, but disadvantages also attend its use. It has been shown to have a much less paralysing influence on the heart than chloroform, and death from heart failure is a much less likely occurrence under the administration of ether than chloroform. It is, therefore, a safer anæsthetic. But the stimulating effects of ether are more prolonged than those of chloroform. It takes a much longer time to induce complete insensibility; there is much more struggling and violence; and more irritation of the air-passages with the vapour, so that even a catarrh may be brought on by its use. The inflammability of ether renders it necessary to be on guard against a light being brought near when it is in use. The risks of chloroform and the disadvantages of ether are both largely diminished by putting the patient under chloroform till insensibility is produced, and then substituting ether to maintain the condition.

Nitrous Oxide, or **Laughing Gas,** is a colourless odourless gas, made by heating nitrate of ammonia. It is a compound of nitrogen and oxygen, and its chemical formula is N_2O. In ordinary circumstances it is a gas, but under pressure it is condensed to a liquid, and kept in strong iron bottles, whence it is allowed to escape for use into a gasometer. It must be inhaled pure without any admixture of air. When so inhaled it takes the place of oxygen in the blood, converts the arterial into venous blood, and as a result a condition, so far as the blood is concerned, resembling suffocation arises. The face becomes livid and bloated, and the breathing stertorous, and muscular twitchings begin to occur. These effects will be produced after about 1 minute's inhalation. The person is at this time completely unconscious, and minor operations, such as extraction of a tooth, &c., can be performed without pain. If the inhalation be stopped at this stage, recovery takes place, and in from ½ to 1 minute all the symptoms named will have disappeared and natural breathing be fully restored. If the inhalation were carried beyond this stage, the action of the heart and of breathing would be arrested. After the immediate effects have passed away, the patient usually feels some degree of exhilaration, and his laughter is readily excited. If this gas be inhaled *mixed with air*, or if after the pure gas has been inhaled for a little, and before it has had time to produce unconsciousness it be stopped and air inspired, a high degree of mental excitement is produced; the patient exhibits an uncontrollable desire to laugh, dance, gesticulate; and sometimes the excitement ends with a fit of pugnacity. But this series of phenomena, on account of which the gas was called "laughing gas", only occurs when the gas is not administered pure, without admixture of air.

Bichloride of Methylene is obtained from chloroform by the action of nascent hydrogen. Its formula is CH_2Cl_2, that of chloroform is $CHCl_3$. So that one atom of chlorine (Cl) has been removed from chloroform, and for it has been substituted one atom of hydrogen (H). It is a colourless volatile liquid, resembling chloroform in smell. It acts very much like chloroform, though it is attended with less risk. It has not, however, come to be very widely used in surgical practice.

Bichloride of Ethylene, or **Dichloride of Ethidene,** is another anæsthetic which for its safety has been recommended as a substitute for chloroform. Its formula is $C_2H_4Cl_2$. It is a colourless thin oily liquid, with a smell like chloroform.

Bromide of Ethyl, Hydrobromic Ether, is prepared by the action of bromine upon alcohol in the presence of phosphorus. Its formula is C_2H_5Br. It is a colourless volatile liquid, of strong ethereal odour and sweet taste. It is said to be an agreeable and rapid anæsthetic, its effects passing off more quickly than those of chloroform, and sickness being less common with it. Its advocates have pronounced it safer than chloroform, though death has happened under its administration.

Iodide of Ethyl, Hydriodic Ether, is a similar preparation, iodine being substituted for bromine, and it also acts as a general anæsthetic. Its chief use is for spasmodic attacks, specially for spasmodic asthma. It is put up in small glass capsules, each containing 5 drops, the capsule being encased in cotton wool and silk. When the attack comes on the capsule is crushed between finger and thumb, and the vapour inhaled through the wool.

Tetrachloride of Carbon (CCl_4), a colourless thin oily liquid of aromatic smell. It produces great weakness of the heart, and is not used for general anæsthesia. It has been used as an inhalation to relieve hay-fever and neuralgic pains.

SECTION IX.—REMEDIES FOR EXTERNAL APPLICATION.

Antiseptics:

Carbolic Acid; Sulphocarbolate of Soda and Zinc; Resorcin;
Boracic Acid and Boroglyceride;
Permanganate of Potash—Condy's Fluid;
Iodoform; Perchloride of Mercury—The Comparative Value of Various Disinfectants;
Eucalyptus Oil; Terebene; Thymol; Menthol; Sanitas;
Chlorine Gas;
Burnett's Disinfecting Fluid

Remedies which Cause Redness and Blister:

Mustard—Its Uses as Poultice, Footbath, and Emetic;
Turpentine; Ammonia Liniment;
Cantharides (Spanish-fly).

Stimulating Liniments, Washes, and Ointments:

Red Wash; Lotions of Zinc; &c.;
Ointments of Boracic and Carbolic Acids, Creasote, Mercury, Iodine, Iodoform, and Tar; Blue, Red, Yellow, and White Precipitate Ointments, Resinous and Sulphur Ointments, Chrisma Sulphur, and Zinc Ointment.

Applications for Bleeding—Styptic or Astringent Applications:

Borax and Alum, Catechu, and Oak Bark;
Hazeline and Matico.

Soothing Liniments, Washes, and Ointments:

Applications of Opium and Belladonna;
Aconite; Carron Oil;
Veratria; Conium; Gall; Acetate of Lead;
Glycerine.

Antiseptics.

Antiseptics (Greek *anti*, against, and *sepein*, to rot) are substances which arrest putrefaction or decomposition. This they effect by preventing the development of the minute organisms on which such decompositions depend. All this has been fully explained at the beginning of Section XII., Part I., p. 384. They are required for external use to prevent putrefaction occurring in wounds, and they are also employed to cleanse instruments, to wash the hands, &c., in order to prevent the conveyance of infective material from one person to another. It has been pointed out on p. 395, that while certain substances only prevent the development of such organisms, other substances absolutely destroy them, and that this latter process is true disinfection. Disregarding, however, such fine distinctions, we shall note in these paragraphs all the various substances employed for such purposes.

Carbolic Acid, Phenic Acid, Phenol, or Phenylic Alcohol, is an acid obtained from coal-tar by fractional distillation and purification. When pure it is in colourless needle-shaped crystals; and on the addition of 6 per cent of water it becomes and remains liquid. Its varieties as sold are as follows:—

No. 1 Carbolic Acid is pure acid, and is obtained in crystals, or with 6 per cent water as a liquid. One part makes a clear solution with 14 of water, and is best adapted for surgical or medical use.

No. 2 Carbolic Acid may be obtained as crystals or liquid. It makes a clear solution with 20 parts of water, is suited for surgical purposes and for the sick-room. 1 oz. in 2 pints of water may be used for sprinkling about.

No. 4 Carbolic Acid consists of 20 per cent carbolic acid and 80 per cent cresylic acid, and is used for disinfecting purposes, for drains, sinks, &c., for which it may be used of a strength of 1 oz. to 2 pints hot water.

No. 5 Carbolic Acid is a liquid adapted for stables, dust-bins, &c.

The preparations of carbolic acid are as follows:—

Glycerine of Carbolic Acid—Carbolic acid 1 oz., glycerine 4 ozs.

Carbolic Acid Ointment—Carbolic acid 1, soft paraffin 12, hard paraffin 6.

Carbolic Acid Lotion—Carbolic acid 1, water 19, or upwards.

Carbolic Oil—Crystals of carbolic acid 1, olive-oil 9.

Vapour of Carbolic Acid—20 drops of No. 1 liquid acid in a pint of water at 140° F.

Spray of Carbolic Acid—3 drops of No. 1 liquid acid in 1 oz. of water.

Carbolic acid is a true disinfectant as well as an antiseptic. In weak solutions it simply prevents the growth of organisms in stronger solutions it destroys them. One part in 40 of water is the strength usually employed for washing hands, and as a lotion for wounds. When it is applied, full strength, to the skin it produces a white stain by destroying the immediate surface, and it greatly diminishes the sensibility of the part. It is frequently used of this strength to destroy foul ulcers, and as a paint for the throat in diphtheritic ulceration, and to apply to the skin in ringworm and other diseases dependent upon low forms of life, while the ointment is used to relieve itching diseases of the skin. The strong acid applied to the cavity of a tooth is one of the speediest remedies for toothache. It is best applied by a small fine camel-hair pencil, the hair being cut short. The cavity is brushed out several times with the brush soaked in the acid, the mouth being frequently rinsed with lukewarm water to remove excess of acid without burning the tongue and gums. The acid in weak solutions (1 to 40, or 1 to 30, or 1 to 20) is employed as a stimulating wash. Carbolic acid makes an excellent mouth wash along with tincture of myrrh and borax and glycerine. Take ½ ounce of each, mix, and make up the solution to 5 ounces with water. A small quantity of this, say about a tea-spoonful, in a wine-glassful of lukewarm water makes a most excellent mouth wash. It most effectively removes from the mouth the smell of tobacco smoke, and besides is an excellent preservative of the teeth and gums. In the form of the vapour, carbolic acid is used in bronchitis and other lung diseases attended by foul expectoration, and 1 part mixed with 3 of creasote may be used on Coghill's inhaler, as described on p. 882, in consumption. Common cold, beginning in the nostrils, is said to be much relieved by a douche of a solution containing 3 drops in an ounce of water, applied to the nostrils by means of a small ear-syringe, and to the throat as a gargle. It is even taken internally in cases of stomach disease attended by fermentative changes, being given in from 1 to 3 drops (No. 1 acid) largely diluted, to destroy the organisms causing the fermentation. Taken in large doses, or in strong solution, it produces the signs of irritation of stomach and bowels, vomiting and purging, and after absorption produces collapse, delirium, perhaps convulsions, and death. Giddiness, headache, lassitude, and unconsciousness also attend poisoning by the acid. Poisonous effects may arise owing to absorption from a large wound covered by carbolic acid dressings. The urine acquires a dark and even black colour from such absorption. In cases of poisoning by swallowing the acid, the stomach should be emptied by means of the stomach-pump or by emetics, then olive-oil should be administered, and thereafter 10-grain doses of sulphate of soda to aid its removal from the blood.

Sulphocarbolate of Soda, and **Sulphocarbolate of Zinc,** are formed from sulphuric and carbolic acid, with soda or zinc, as the case may be. The former is given internally in 10 to 15 grain doses to prevent fermentation in the stomach, and the latter is used in solution, 2 grains to 1 ounce of water, as a stimulating and antiseptic dressing for wounds with discharge.

Resorcin is a derivative of carbolic acid. It is used as a dressing for wounds and sores of all kinds in solutions varying in strength from 1 to 50 to 1 to 20 of water. It has been used in diphtheria as a paint to the throat, and an ointment made with ¼ to ¾ oz. vaseline, applied to the face every 4 hours in erysipelas, is said to shorten the disease. A 1 per cent solution is a useful dressing for wounds. It is given internally, 5 grains with syrup of oranges and well diluted, to prevent fermentation in the stomach. It may be used for this purpose thrice daily before meals. It produces copious perspiration and has been employed to reduce fever of all kinds.

Creasote is a product of the distillation of wood-tar. Its dose and preparations are as follows:—Creasote—dose, 1 to 3 drops. Vapour of creasote (creasote 80 drops, light carbonate of magnesia 30 grains, water to 1 ounce), a teaspoonful to a pint of water at 140° F. for inhalation. Creasote ointment, 60 drops to 1 ounce simple ointment. Creasote destroys low organisms and is employed for this property. Thus it may be used to stop toothache in a decayed tooth, as carbolic acid is used (see first col.). It is used in chronic bronchitis and in consumption to lessen cough and spit, either as vapour, or dropped on the lint of a Coghill inhaler (see p. 883), or it may be administered internally with cod-liver oil, 1 to 3 drops to each dose of the oil. The ointment may be employed as an antiseptic dressing.

Boracic Acid, or Boric Acid, is in the form of colourless, odourless plates, with a slightly bitter taste. It also is an antiseptic and is used for wounds and sores as a lotion, 1 oz. in 20 of hot water, or as an ointment. The ointment may be made of boracic acid in fine powder 3 ounces, paraffin melting at 135° 5 ounces, and vaseline 10 ounces, and is an excellent healing application. Boracic acid is largely used for the preservation of milk. The powdered acid, mixed with starch, is a useful dusting powder for infants; and the powder itself sprinkled in the socks prevents the disagreeable odour of sweating feet.

Boroglyceride is a patented preparation made by heating 92 parts of glycerine with 62 parts of boracic acid. It is used as a preservative of meat, fish, milk, being used in solution for that purpose, 1 in 40 of water. It is also used as a surgical dressing.

Sulphurous Acid, a solution of sulphurous acid gas in water, is a powerful destroyer of decomposing material. This it effects by removing oxygen from the organic substance and thus destroying it. It is the gas which is liberated from burning sulphur, which is employed as a disinfectant. It is applied as a lotion, 1 oz. to 2 or more of water with the addition of a little glycerine, to ringworm, thrush, and as a spray in sore-throat. It is also given in doses varying from a few drops to a tea-spoonful, well diluted, in cases of vomiting dependent upon fermentation in the stomach.

Permanganate of Potash occurs as dark purple crystals, which readily dissolve in water to a pink solution. It is a substance which quickly destroys organic matter by giving off oxygen which unites with the organic substance. **Condy's red fluid** is a solution of the strength of 2 grains to the ounce of water. It is a powerful disinfectant, and will remove the smell from foul sores and destroy any foul smell on the hands. A few grains only need to be dissolved in the water and the hands well washed with it. It has been recommended for internal administration in cases of absence of the monthly discharge, being given in pill, 2 or 3 grains in each, three or four times daily for some days before the illness is due.

Permanganate of Soda in solution is also used as a disinfectant, and is a green solution.

Iodoform, a compound of carbon hydrogen and iodine, is a powder in shining lemon-yellow crystalline scales, with a very powerful and disagreeable odour. It is a strong antiseptic, but its own persistent and easily perceived odour renders it less desirable for use. The smell is covered by equal parts of it and Tonquin bean or by ground coffee. It diminishes the sensibility of the part to which it is applied. It is very useful as an application to foul sores, or to sores or wounds about the anus. It may be dusted on as a powder, or applied as an ointment, 1 in 4 or less of vaseline. As a snuff it is useful in common cold in the head. Made into suppositories, 5 grains in each, it is a most useful application to irritable and indeed all kinds of piles. It is occasionally administered internally, $\frac{1}{2}$ to 3 grains in pill; and has been so employed with success in ulceration of the stomach. It may produce disagreeable effects on the nervous system, sleeplessness, headache, irritability, and loss of memory. These effects are said to be lessened be 10-grain doses of bicarbonate of soda or potash every hour.

Perchloride of Mercury Solution—Solution of Corrosive Sublimate (see p. 824). This is one of the most powerful of known antiseptics. Dr. Koch of Berlin, who has done more than anyone else in the way of systematic study of the causes of putrefaction and decomposition and the circumstances which favour or hinder their growth, has made a series of comparative experiments with the organism that is the cause of splenic fever (see p. 391), and various disinfectants. He found that a solution of

1 part of Carbolic Acid in	1,250	parts of water	hindered the	growth of the	organism.
1 part of Boracic Acid in	1,250	,,	,,	,,	,,
1 part of Chlorine in	1,500	,,	,,	,,	,,
1 part of Eucalyptol in	2,500	,,	,,	,,	,,
1 part of Camphor in	2,500	,,	,,	,,	,,
1 part of Permanganate of Potash in	3,000	,,	,,	,,	,,
1 part of Oil of Cloves in	5,000	,,	,,	,,	,,
1 part of Peppermint Oil in	33,000	,,	,,	,,	,,
1 part of Thymol in	80,000	,,	,,	,,	,,
1 part of **Corrosive Sublimate** in	**1,000,000**	,,	,,	,,	,,

The enormous superiority of this antiseptic agent over every other in its destructive power is, therefore, apparent. One grain dissolved in one million grains of water still exerts its antiseptic power; and if the strength is increased threefold and made 1 grain in 300,000 the growth of the organism is not only hindered but totally prevented! One grain dissolved in 40 pounds weight of water is 1 in 300,000, that is in round numbers 1 grain in 4 gallons of water. It is, therefore, very extensively used as a disinfecting lotion to wounds, as a disinfecting uterine injection after child-birth, and to impregnate gauze, lint, cotton wool, prepared as dressing for wounds. The strength of solution employed for disinfection purposes varies from 1 in 1500 to 1 in 10,000. One grain dissolved in 10 ounces ($\frac{1}{2}$ pint) of water makes a solution a very little stronger than 1 in 5000. This can be used for disinfecting hands, for uterine injection after child-birth, care being taken that it runs freely from the passage and is not retained. The author is accustomed to order such a solution in cases of scarlet fever for sponging the patient's body. The whole body is sponged daily, beginning a few days before the skin begins to peel, say on the sixth or seventh day of the fever, throughout the whole illness till all the peeling skin has been removed, that is to the end of the sixth week. After the sponging the body is lightly anointed with carbolic or other oil. In this way disinfection is achieved throughout the illness, and risk of the spread of the disease reduced to as little as it is possible.

Eucalyptus.—The *Eucalyptus globulus* or *Blue Gum-tree*, of the natural order Myrtaceæ, belongs to Tasmania. It was introduced into Europe in 1856, and has since been planted in the southern part of Europe, in Northern Africa, Southern United States, and California. It is a rapid grower, and attains a height of 200 feet. The leaves of old trees have a length of 6 to 12 inches, and have a strong camphoraceous odour; and they yield 6 per cent of a volatile oil, called oil of eucalyptus, or **Eucalyptol**. To eucalyptus the power of curing malaria has been ascribed, and the tree has been freely planted in malarious districts in the belief that it destroys malaria in the locality. It is undoubtedly a powerful antiseptic and disinfectant, and is used for surgical dressings. Internally it has been used in blood-poisoning, and in consumption, bronchitis with foul-smelling expectoration, and in catarrhal conditions of the bladder. It may be administered in doses of from 1 to 5 drops made into an emulsion with gum tragacanth and any flavouring syrup. It is removed from the body by the lungs and kidneys, and may thus exert upon them a special healing influence. A tincture of eucalyptus leaves may be made by steeping one part of the leaves in sufficient proof spirit to produce 5 parts of tincture, of which the dose is 15 drops to 2 tea-spoonfuls. This is a very suitable form of administration, and in lung affections may be added to cod-liver oil, the fishy flavour of which it removes. It may be used for inhalation with Coghill's inhaler (see p. 883); and 10 to 60 drops of a mixture of equal parts of the oil and rectified spirit are used as an inhalation in diphtheria.

Terebene is prepared from oil of turpentine by oxidation with sulphuric acid. It is used for inhalation as eucalyptol, and is also given internally in doses of 5 to 20 drops, chiefly in chronic bronchitis, and other lung affections, as it acts as a stimulant to the mucous membrane. It is sometimes used for flatulent distension of the stomach when the cause is fermentative changes in the food. It is a powerful antiseptic and deodorant.

Thymol is a crystalline substance obtained from the volatile oils of common thyme and other plants. It is a strong antiseptic (see p. 912) and disinfectant. When given internally it is expelled by lungs and kidneys, irritating their lining membrane. It is used in surgery, and is also employed as gargle in sore-throat, and as inhalation in lung affections. It is also employed for skin diseases, and a thymol soap is prepared. When given internally the dose is ½ to 2 grains and upwards, taken in pill with soap or in oily solution.

Thymol Lotion—for antiseptic purposes and disinfectant for sick-room, 1 part thymol in 800 warm water.

Thymol Ointment—5 to 30 grains to 1 oz. vaseline.

Thymol Vapour—6 grains thymol, 1 drachm rectified spirit, 3 grains carbonate of magnesia, water to 1 ounce. A tea-spoonful to 1 pint of water at 140° F. for inhalation in catarrh of air-passages.

Menthol, Peppermint Camphor, a white crystalline substance distilled from the fresh *Mentha arvensis* and *M. piperita*. It is a strong antiseptic. When rubbed on the skin it causes a burning sensation, replaced by a feeling of intense coldness if the part is blown upon. It is usually sold in the form of cones, **neuralgic cones**, for rubbing on any part affected with neuralgia, or the forehead for headache, &c. Liniment of menthol is made with 3 parts of menthol, 4 of chloroform, and olive-oil to 16, and is used for lumbago, neuralgia, and sciatica. Chinese oil of peppermint, called *Po-ho-yo*, Japanese Drops, or *Gouttes Japonnaises*, is sold in small bottles for the relief of neuralgia. It contains much menthol, from which it derives its properties.

Sanitas is a patent preparation, derived from turpentine, which owes its disinfectant properties to ozonic ether or peroxide of hydrogen.

Chlorine Gas is a greenish-yellow gas, with a suffocating odour. It is the active agent in bleaching powders, and is contained in the so-called chloride of lime, which is, properly speaking, chlorinated lime. This chlorinated lime is used for disinfecting properties, as it gives off chlorine slowly when exposed to the air. The vapour is heavier than air, and in order to permeate an apartment ought to be allowed to pass off nearer the roof of an apartment than the floor, for then it will sink and mix with the air of the room. The dish containing the chlorinated lime should, therefore, be placed on a high shelf. Another method of obtaining it is to put a saucer containing salt, binoxide of manganese, and sulphuric acid on a high shelf; chlorine is evolved from the mixture. Another way is to make a strong solution of chlorinated lime, dip cloths into it, and hang them on a line stretched across the apartment near the roof. The cloths, it must not be forgotten, will be destroyed by the strong solution. Solutions of chlorinated lime or of chlorinated soda are employed to disinfect the hands or to disinfect wounds and ulcers.

Burnett's (Sir Wm.) **Disinfecting Fluid** is a solution of chloride of zinc of specific gravity 2.

Remedies which Redden and Blister the Skin.

One method of treating diseases continually employed in medicine is that by **counter-irritation**. This implies that when one part of the body is in a disturbed state, subject to pain, to threatened inflammation, &c., a neighbouring part is so acted on as to markedly irritate it and cause a rush of blood to it. That is to say, a temporary inflammation is aroused in the neighbouring part, and the disordered portion is in consequence relieved. The blood which is drawn to the place that is the seat of the counter-irritation is to some extent withdrawn from the threatened district. Thus when a mustard poultice is applied to the chest, so that the skin is reddened, the deep parts are relieved to the extent to which the blood attracted to the surface has come from the deep parts. Not only is the threatened part relieved by a diminished blood-supply, but it is believed that the irritation by nervous action will modify its activity and assist in the relief. There are various degrees of counter-irritation. By one set of remedies only a temporary redness of the skin is produced. These are called **rubefacients** (Latin *rubrum*, red, and *facio*, I make), and include hot water and hot applications, mustard, ammonia, camphor, vapour of chloroform, ether, turpentine, and various aromatic substances. The next degree of counter-irritation is that produced by a blister, a **vesicant** (Latin *vesica*, a blister); they are also called **epispastics** (Greek *epi*, upon, and *spao*, I draw). The chief of these is Spanish-fly or cantharides. Ammonia when long applied and confined acts thus, and iodine also. A third degree of counter-irritation is effected, when the remedy produces a crop of pustules, such as is produced by croton-oil. By the second and third degrees not only is a more profound effect produced at the time, but it lasts much longer, and its beneficial effect is thus maintained without further trouble.

Mustard.—There are two varieties of mustard—white and black, the former derived from *Brassica* (or *Sinapis*) *alba*, and the latter from *Brassica nigra* (p. 593).

A mustard poultice is prepared by mixing 2½ ounces of mustard with 2 or 3 ounces lukewarm water. Mix a similar quantity of linseed meal with half a pint of boiling water, then add the mustard mixture, stirring constantly. Where a less active poultice is desired, double the quantity of linseed meal may be taken.

Mustard paper is cartridge paper spread with mustard mixed with a solution of gutta percha. It should be immersed for a few seconds in tepid water before being applied, and should be well pressed down on to the skin. The Rigollot's mustard leaves are the form chiefly used. They act with great rapidity, reddening the skin with intense burning pain in 2 or 3 minutes. They need not be left on longer than 10 to 15 minutes, and even 5 minutes may be enough if they cannot be longer borne. In cases of persons with very delicate skin a layer or two of damped muslin may be placed between the leaf and the skin to make the action less violent.

A mustard foot-bath may be used as a general stimulant, for example, at the commencement of a common cold. In such a case the water should be as hot as can be borne, and two table-spoonfuls of mustard or thereby may be used. It may be used as a derivative, to draw blood from the head in head affections or from the lungs in chest affections. For this purpose the water should be only lukewarm.

A general mustard bath is sometimes employed. For children a table-spoonful of mustard should be added to the bath sufficiently large for the child, and the child held in it by the nurse's arms till they tingle. It is used in bronchitis, and in the fevers with rash where the eruption has not been well developed or has faded too soon. The water should be only lukewarm. For adults a general mustard bath would require from 2 to 3 ounces and upwards of mustard.

Mustard-oil is the oil distilled from the seeds of mustard after they have been steeped with water. It is used as a stimulating liniment and for similar purposes to mustard itself.

Compound Liniment of Mustard is made of oil of mustard 1 drachm, ethereal extract of mezereon 40 grains, camphor 120 grains, castor-oil 5 drachms, and rectified spirit 32 drachms.

This may be used simply as a liniment, or sprinkled on some material like spongiopiline or even flannel, and applied as a mustard leaf would be.

The Uses of Mustard.—Mustard poultices are employed in pleurisy, inflammation of the lung, bronchitis, &c., to withdraw the blood from the interior of the chest. For these purposes the larger the poultice the better, and while the risk of raising a blister is to be carefully avoided, the skin should in a short time be made quite red. The effect should be kept up for a considerable period, 24 hours or more, by a judicious reapplication of the poultice at appropriate intervals. If the poultice is properly made and put on warm enough to act quickly as it ought to do, two or three poultices in the 24 hours ought to be quite sufficient. A poultice ought not to be kept on longer than 15 to 20 minutes at a time. If it is properly made it can hardly be borne longer, and if it is properly made a 10-minutes' application ought to be sufficient. Many people apply poultices and no redness of skin is perceptible after even an hour. This simply means that the mustard has not been active, either because it is bad or because the essential oil has been driven off by too great heat, or from some defect in application. A blister produced by mustard is painful and slow to heal, and always to be avoided. If a blister has been produced carron-oil (p. 844) is to be applied, and later zinc ointment.

Vomiting is often speedily relieved by a mustard poultice over the pit of the stomach; a mustard poultice applied to the nape of the neck will often remove headache very speedily; and a mustard poultice or leaf applied to the small of the back is very effective in relieving pain in that region, to which many people are subject after a fatiguing day's work or excitement. Large mustard poultices over the belly are required in pain there, specially if inflammatory mischief is threatened.

A mustard foot-bath is useful in common cold (see above) in relieving headache, in procuring sleep, to remove excess of blood from the head, and is very serviceable in cases of painful monthly illness. When the illness is arrested or suppressed, a mustard sitz-bath, each day during the time the discharge is due, is of value. Flying mustard poultices, a large mustard poultice applied for a few minutes, here and there, on different parts of the body, on the chest, belly, thighs, &c., are useful as a general stimulant in rousing a person suffering from opium-poisoning.

For hoarseness, inflammation of the windpipe or larynx, a mustard poultice ought never to be applied directly over the front of the throat. Owing to the thinness of the tissues intervening between the surface and the interior of the throat, only increase of swelling and a greater degree of hoarseness or difficulty of breathing would result from the rush of blood to the part. Particularly is this the case in children. Therefore the poultice ought always to be applied lower down, at the root of the neck or the upper part of the chest in front.

A tea-spoonful of mustard in a tumblerful of water is the dose for emetic purposes (see p. 851).

Turpentine has been already discussed on p. 872. It is largely used as a stimulating application to relieve pain and inflammation in affections of the chest and bowels, in neuralgia, lumbago, sciatica, &c. A good method of applying it is to sprinkle the turpentine on a piece of flannel, sufficient being used to damp the flannel. This is applied over the part of the skin to be acted on. Above this is put a thick pad, made of several layers of flannel, wrung out of water as hot as can be borne. The whole is secured by a broad bandage. It is to be kept on till the skin is quite red, but short of blistering, and it will blister when the vapour is confined in this way, if it be kept on long enough. The part may then be dressed with a layer of cotton wool secured by a bandage, or with a sheet of lint moistened with olive-oil.

Ammonia (see p. 843), the spirits of hartshorn, is employed as a counter-irritant in the same way as mustard or blisters. It may be applied sprinkled on flannel or lint, and it reddens the skin in a few minutes, when it should be removed.

Liniment of Ammonia, "Hartshorn and Oil," is best suited for this purpose, 1 part of hartshorn and 3 of olive-oil. This also is applied in flannel or lint.

The strong ammonia may be employed to produce a blister as follows:—Cut a piece of lint a little longer than the desired blister. On this pad pour 10 or 20 drops of the strong solution of ammonia, apply to the skin and cover with a good-sized watch-glass. In a short time, when the skin has become quite red, the lint is removed and a poultice applied, which raises the blister in from ten minutes to half an hour. It is, however, not quite certain, the skin of some not being blistered by it. Spanish-fly is much more reliable, and for the mere production of redness mustard is better.

The liniment is, however, an admirable stimulating liniment for painful and swollen joints, for stiff joints, for rubbing over sprained parts after all acute pain has ceased, and for similar purposes.

Iodine is described on p. 825. The preparations employed for external application are the tincture, the liniment (made with 5 parts of iodine, 2 of iodide of potassium, 1 of camphor, and 40 of rectified spirit), and the ointment. There is also a preparation called colourless iodine, made with iodine and hyposulphite of soda, which does not stain the skin. If the skin is not too tender two coats of the liniment should be painted on with a camel-hair pencil; but if the skin is delicate one coat is enough.

It is painted on the back of the chest in chronic pleurisy to promote the removal of the fluid accumulated in the chest cavity; and it is advised to be painted on the front under the collar bones to relieve the harassing cough of consumption. For the relief of pain a mustard poultice is better. It may be painted round chronically swollen joints, but small frequently repeated blisters are more serviceable. It ought never to be used by unskilled persons to paint over swollen glands. If any pain and tenderness exist in the gland the chance of exciting inflammation and the formation of matter is great (see p. 209); and many children are permanently disfigured by such a result. The ointment well rubbed over chilblains, so long as the skin is unbroken, is often sufficient to effect a cure in two or three days.

Spanish-flies.—This is the dried insect *Cantharis vesicatoria*, belonging to the beetle order, Coleoptera. It is indigenous to Southern and Central Europe, frequents chiefly trees and shrubs, such as ash, lilac, elder, and honeysuckle. It is from ½ to 1⅕ inch long and ⅕ to ⅓ inch broad, and of a shining metallic green colour. The beetles are collected in early morning by shaking them off the trees into white cloths spread below. They are killed by immersion in hot water and are then dried. They are reduced to powder, which is greyish-brown in colour and contains shining green particles. The chief preparations are :—

Tincture Cantharidis.
Blistering Paper (Charta Epispastica or Cantharidis).
Cantharides Plaster—Blistering Plaster (Emplastrum Cantharidis or Lyttæ).
Blistering Fluid—Liquor Epispasticus.
Cantharides Ointment.

This blister when applied to the skin first reddens and then causes the production of a large bleb filled with fluid. The blistering action is due to an active principle called cantharidin. The blistering plaster is spread on leather or adhesive plaster in a layer about the thickness of a sixpence, and the surface is lightly touched with oil. If the skin over which it is to be applied is washed with soap and water and then bathed with vinegar, the plaster will act better. If only a slight degree of action is wanted the blister should be removed in three or six hours, and a piece of carded cotton applied to the part; if more energetic action is wanted it should be left for 12 hours, and dressed, after the raised skin is snipped through, with lint soaked in oil. The blistering paper is less energetic than the plaster. The blistering fluid is applied by painting it over a portion of skin the extent of the desired blister, and then applying several hot poultices.

It is scarcely possible to indicate here when a blister is suitable and when it is not. It is needful to say that blisters should never be employed at haphazard, specially large blisters. They are very often far too readily employed. Specially in the case of the young and the old must they be used with discrimination, if used at all, the risks of destroying the skin in mass are so considerable. It is to be remembered that a very considerable depressing effect is produced on a person by the action of a blister, both on account of the fluid withdrawn from the blood and by the effect on the nervous system. The weakening effect will be all the more pronounced the larger the blister is. As a general rule it may be said that if blisters are resorted to in the absence of skilled medical advice, it is better to apply small flying blisters than large ones, that is a small blister—varying from the size of a shilling to that of a crown piece—may be applied to a particular spot on one day, a second in its neighbourhood the next day, and so on, each being allowed to heal as quickly as possible. Such blisters are applied on the temple and at the back of the ear for inflammations of the eye and ear; they are applied round swollen joints to remove pain and swelling, as at the knee-joint, at the nape of the neck to relieve giddiness and head symptoms, over the heart to relieve pain there, over the pit of the stomach to relieve vomiting, down the spine to relieve spinal irritation, and on the painful spots of a nerve to remove neuralgia. A long narrow blister down the back of the thigh is often useful in sciatica. In acute rheumatism large blisters applied round the limb above and below the affected joint are strongly advocated.

If taken internally, Spanish-flies produce marked irritation of stomach and bowels, with vomiting and purging, as well as severe inflammation of the kidney and strangury. Very large doses produce delirium, spasms, stupor, and death.

The application of large blisters is liable in many people to produce marked signs of irritation of the kidneys and bladder. This is supposed to be prevented by sprinkling the surface of the blister with finely-powdered camphor or by painting it over with tincture of camphor.

The stimulating effect which cantharides has upon the skin is made use of to promote the growth of hair. **Erasmus Wilson's Hair Wash** consists of vinegar of cantharides 1 part, glycerine 1, tincture of bark ½, orange-flower water 8, and rose water 8.

Poisoning by Spanish-flies is to be met by emptying the stomach by an ipecacuanha emetic and then giving large draughts of gummy water, oil and spirit being avoided, as they dissolve the active principle. To relieve irritation of kidneys and bladder, warm sitz-baths and opium are advised.

Croton-oil has been sufficiently referred to on pp. 861, 862.

Stimulating Liniments, Washes, and Ointments.

Stimulating liniments or **embrocations** are specially employed to relieve stiffness after inflammation or injury, to remove thickening and swelling when all acute pain has passed, and to restore the full use of the part. As a general rule these liniments are not to be employed until all active inflammation has passed. Thus suppose a person sprains an ankle or a wrist, rubbing and the application of any stimulating material could only aggravate the pain. It is rest and soothing applications, such as warm cloths, that are desired, and when all the acute results have passed, then rubbing with a liniment, gently at first, and then, after trial has shown it to be quite safe, more vigorously, will remove the remaining swelling, get rid of the stiffness, and restore the full use of the part.

The chief stimulating liniments are:—

Arnica Tincture.
Hartshorn and Oil—Liniment of Ammonia.
Camphorated Oil—Liniment of Camphor.
Compound Camphor Liniment (camphor 2½ ozs., oil of lavender 1 drachm, strong ammonia 5 ozs., rectified spirit 15 ozs.).
Iodine Liniment.
Soap Liniment.
Soap and Opium Liniment—Opodeldoc.
Compound Mustard Liniment.
Liniment of Turpentine (turpentine-oil 16, soft soap 2, camphor 1; dissolve the camphor in the turpentine and then rub up with the soap).

Arnica is the root-stock of *Arnica montana*. This is used for the tincture, and there is also a tincture of the flower-heads. It is used for bruises and sprains, but should not be rubbed on till after all acute pain has ceased, as it is capable of setting up inflammation.

Stimulating lotions are for ulcers, wounds, &c., which are slow of healing because of a defective blood supply. The ulcer or wound of this kind is pale in colour, smooth on the surface, not covered over with the little sprouting granulations which every healing wound shows. The edges are thick, white, and not sensitive, and the discharge is thin and scanty.

The chief lotion for such cases is the

Red Wash (sulphate of zinc 16 grains, spirit of rosemary and compound tincture of lavender, of each 2 drachms, water to 8 ozs.).

Other stimulating lotions are:—

Black Wash (30 grains calomel, ½ pint lime water).
Yellow Wash (18 grains corrosive sublimate, ½ pint lime water).
Sulphocarbolate of Zinc (2 grains to 1 oz. water).
Corrosive Sublimate (1 grain to 1 oz. water).
Chloride of Zinc (2 grains to 1 oz. water).

Stimulating Ointments are as follows:—

Boracic Acid and Carbolic Acid Ointments.
Creasote Ointment (p. 911).
Blue Ointment.
Red Precipitate Ointment.
Yellow ,, ,,
White ,, ,,
Citrine Ointment.
Scott's Dressing.
Chrysophanic Acid Ointment.
Iodine, Iodoform, and Tar Ointments.
Resinous Ointment.
Sulphur Ointment.
Chrisma Sulphur.
Zinc Ointment.

The three ointments that head the list are stimulating and antiseptic ointments. The blue, red, yellow, and white precipitate, citrine ointments, and Scott's dressing, are all mercurial preparations. The first four of them are all used to destroy insects.

The **Red and Yellow Precipitate** ointments are specially useful in inflamed conditions of the eyelids, being applied at night, and as a stimulant to chronic inflammatory eruptions of the skin.

The **Citrine Ointment** is similarly used.

Scott's Dressing consists of strong blue ointment 6 parts, yellow wax, and olive-oil, of each 3, and camphor 1½. The camphor in fine powder is added to the melted wax and oil when nearly cold, and the blue ointment next. It is applied to chronically inflamed and swollen joints. The dressing is spread on a sheet of lint, which is then cut up into strips, these are wrapped round the joint, one overlapping the other till the joint is completely enveloped. Strips of adhesive plaster are then applied in the same way as tightly as possible, and over all a starch bandage is applied. In two or three weeks it is removed, and the swelling will usually be found greatly subdued. If owing to diminished swelling the application becomes loose, it should be removed and reapplied.

Iodine Ointment may be used like the liniment for stimulating purposes, and is very useful for chilblains.

Chrysophanic Acid Ointment is made with chrysophanic acid or chrysarobin 1 part, and benzoated lard 10 parts.

Chrysophanic acid is derived from Araroba or Goa powder, a concretion from clefts in the stem of *Andira Araroba*, a leguminous tree imported from Brazil. It is an orange-yellow powder.

The ointment is very stimulating to the skin, destroys low vegetable organisms in the skin, and is very successfully used in scaly diseases such as psoriasis, and in ringworm. It stains the skin and clothing. Clothing containing starch it colours blue; therefore linen or cotton should not be worn during its use.

Iodoform Ointment is employed for foul ulcers, indolent sores, and unhealthy wounds.

Tar Ointments are specially resorted to in skin affections, in eczema, psoriasis, ringworm, prickly heat, and specially to relieve ringworm.

Resinous or **Basilicum Ointment** is a popular dressing for indolent sores. It is made of resin or colophony, the residue left from the various species of pine after distilling off the oil of turpentine. Two parts of resin in coarse powder, 1 part of yellow wax, and 4 parts of simple ointment are melted together with gentle heat, strained while hot through flannel, and stirred till cold. Simple ointment is made of 2 parts white wax, 3 of prepared lard, and 3 of almond oil melted together and stirred till solid.

Sulphur Ointment is used in itch, in eczema, ringworm of the head, and many other skin affections.

Chrisma is a petroleum preparation like vaseline, and has the property of dissolving sulphur. In consequence chrisma sulphur is more active than the common sulphur ointment. It is specially valuable in eczema, specially when found in the head and face of children, to which it should be freely applied, after the scabs have been removed by diligent soaking with water, or after softening with a turnip poultice.

Zinc Ointment is the common white "healing ointment." The oleate of zinc ointment is preferable to the common zinc ointment. It is made of 1 ounce of oleate of zinc and 1 ounce of vaseline, and may be made weaker, ½ or ¼ oz. oleate to the ounce of vaseline. This form is easily removed from the sore or ulcer, and does not coat it with an irritating crust. Besides for ordinary wounds and sores, it is often useful in chronic eczema.

Astringent Lotions and Washes.

Astringents are applied to the surface of the body to cause contraction of the part, to lessen discharge, to give a tone to the part, to cause ulcers and wounds to take on a more healthy action, to diminish their size, and make the healing surface less flabby and soft. Used as eye lotions they diminish inflammation and the flow of matter, as gargles or spray they lessen the secretion of phlegm and strengthen the throat, and as injections to the genital passages or womb they are used to lessen congestion and discharge. The chief astringents have already been discussed on p. 867 and two following pages in connection with their internal use in diarrhœa.

Borax and Alum Lotions, 2 tea-spoonfuls of the former to a pint of water, a tea-spoonful of the latter to a pint are useful astringent injections.

Catechu Lotion is made with 60 grains catechu to 8 ozs. hot water.

Oak-bark Lotion requires 2 ozs. of the bark to 1 pint of water, boiled down to a half.

The stimulating lotions mentioned above are useful for similar purposes or for the bathing of wounds.

For use as a gargle borax may be used, 120 grains to 1 oz. tincture of myrrh and 8 ozs. water; or borax 120 grains in 1 oz. glycerine, used as a paint to sores of mouth and throat.

Alum may be used as gargle, 80 grains to 1 oz. tincture of myrrh and 8 ozs. water, or tannic acid 35 grains, tincture of myrrh 4 drachms, and eau de cologne 1½ ozs., for soft and sore gums.

Chlorate of potash ¼ oz., tincture of myrrh and borax ½ oz., glycerine 1 oz., and water to

4 ozs. make a useful gargle for ulcerated throat and mouth.

For Sprays to the Throat, sulphurous acid ¼ oz. to 1 oz. of water, or an increased strength up to equal parts, dried alum 3 to 20 grains to 1 oz. water, tannic acid 3 to 12 grains to 1 oz. water, borax 5 to 20 grains to 1 oz. water, chlorate of potash 5 to 10 grains to 1 oz. water, tincture of steel 5 to 30 grains to 1 oz. water, sulphate of zinc 3 to 15 grains to 1 oz. water, may all be employed.

Applications for Bleeding.—When astringent substances are applied to arrest bleeding they are called **Styptics.** Alum, catechu and oak-bark, borax, and tannin can all be used for this purpose. Hazeline is an admirable remedy for this purpose, and a solution of 1 grain sulphate of iron to 1 oz. water.

Styptic Colloid is a preparation made by saturating alcohol with tannin and then adding ether and gun-cotton. When painted over the part it stops the bleeding and leaves the surface protected by a film.

Matico Leaves, the dried leaves of *Piper angustifolia* from Peru, are used to arrest bleeding from small wounds, such as leech bites. The leaf contains tannin, and an infusion is astringent. Of the infusion the dose internally is 1 to 4 ozs., of a fluid extract (American) ½ to 3 tea-spoonfuls, and of tincture the same.

Compound Tincture of Benzoin, or Friars' Balsam, is the popular application for bleeding wounds. It is not cleanly enough.

Soothing Liniments, Washes, and Ointments.

The **Soothing Liniments** are employed to relieve pain. They are:—

Liniment of Aconite.
,, ,, Belladonna.
,, ,, Lime (Carron-oil, equal parts of lime-water and linseed-oil).
,, ,, Chloroform.
,, ,, Opium.

The liniment of aconite is used in neuralgia and sciatica, rubbed along the course of the affected nerve, and for painful and swollen joints, and it is rubbed over muscles in muscular rheumatism. The liniment relieves pain by diminishing the sensibility of the part. Great care requires to be exercised lest some becomes absorbed and affects the general system (see p. 834). Belladonna liniment is similarly employed, and is often mixed with aconite liniment as well as with liniment of chloroform.

Carron-oil is the most soothing application for burns.

Liniment of opium or soap and opium liniment is used for painful swellings, lumbago, &c.

Soothing Lotions, &c. are:—

Lead Lotion, or Goulard's Lotion.
Opiate Lotion (30 grains powder of opium, 8 ozs. boiling water; strain after 2 hours).
Poppy Lotion (extract of poppy 120 grains, 4 ozs. boiling water).
Conium Lotion (60 grains extract of conium, 3 ozs. water).
Belladonna Lotion (20 grains extract of belladonna, 4 ozs. water).
Glycerine.

All these may be applied to irritable sores, sores which fail to heal from excess of action (see p. 366), and which are hot, tender, raw-looking, and painful. There is a thin acrid discharge, and they bleed on the slightest touch.

Soothing Ointments, which are used for similar purposes to the soothing lotions, are:—

Atropine and Belladonna Ointment.
Aconitia Ointment.
Gall and Opium Ointment.
Acetate of Lead Ointment.
Marsh-mallow or Althæa Ointment.
Veratrine Ointment.
Vaseline.
Lanoline.

The uses of these have been sufficiently indicated by what has been said above.

The aconitia ointment is not to be used without medical advice; its strength as a poison is so great.

Gall and opium ointment is not only soothing but astringent, and is used for piles.

The acetate of lead ointment is one of the most useful of these applications.

Veratrine ointment acts like aconite, diminishing the sensibility of the nerves of the skin, and is used for neuralgic affections.

Vaseline or Petroleum Ointment is a substance obtained by distilling off the lighter portions of American petroleum. It does not become rancid, and is a protection to all raw surfaces.

Lanoline is a purified fat obtained from sheep's wool. It may be used as vaseline or simple ointment is used. It is very largely used as a basis for ointments, since it is readily absorbed by the skin, and drugs mixed with it and rubbed on the skin enter the system much more rapidly than if mixed with ordinary lard or vaseline. Agnine is the term applied to a similar substance in America.

SECTION X.—MINERAL BATHS AND WELLS.

- The Action of Pure Water on the Body.
- The Action of Mineral Waters on the Body.
- Classification of Mineral Waters:
  - *Indifferent Waters*—Thermal Springs;
  - *Common Salt Waters*—Simple Saline Waters—Muriated Saline Waters;
  - *Bitter or Aperient Waters*—Sulphated Waters;
  - *Soda or Alkaline Waters;*
  - *Muriated Alkaline Waters*—Soda Waters with Common Salt;
  - *Sulphur Waters;*
  - *Lime Waters*—Earthy or Calcareous Waters;
  - *Iron Springs*—Chalybeate Waters;
  - *Iodine and Arsenical Waters.*
- Routine of Life at a Spa—Bath-fever.

Indifferent Waters—Thermal Springs—Wildbäder:

Aequi—Badenweiler—Bagnères de Bigorre—Bath—Bormio—Buxton—Gastein—Hammam Meskoutin—Hammam R'Irrha—Hot Springs (Arkansas and Virginia)—Johannisbad—Landeck—Leukerbad (Leuk, Lœche-les-Bains)—Liebenzell—Lucca—Luxeuil—Matlock—Neris—Neuhaus—Panticosa—Pfäffers—Plombières—Ragatz—Römerbad—Schlangenbad—Teplitz—Tobelbad—Tüffer—Warmbrunn—Wildbad.

Common Salt Waters—Muriated Saline Waters—Sool Baths:

Adelheidsquelle—Baden-Baden—Bex—Bourbonne-les-Bains—Canstatt—Cheltenham—Cronthal—Dipso or Aedepsos—Droitwich—Dürkheim—Halt—Heilbrunn (Adelheid Spring)—Homburg (Elizabeth Spring)—Ischia—Ischl—Iwonicz—Kissingen (Rakoczy Spring)—Kreuth—Kreuznach—Leamington—Mergentheim—Mondorf—Nauheim—Neuhaus—Pyrmont (Salt Spring)—Rehme Oeynhausen—Reichenhall—Saratoga (Empire Spring)—Schmalkalden—Soden (Nassau, and near Aschaffenberg)—Thermia—Wiesbaden—Wildegg—Woodhall.

Bitter Waters—Aperient or Sulphated Waters:

Aesculap—Bedford Springs—Bertrich—Birmensdorf—Carlsbad (Sprudel)—Cheltenham—Elster—Epsom—Franzensbad (Franzensquelle)—Friedrichshall—Füred—Hunyadi Janos—Leamington (Saline Spring)—Marienbad (Kreuzbrunnen)—Mattoni's Royal Hungarian Bitter Water—Mergentheim—Ofen or Buda—Püllna—Purton—Rohitsch (Tempelbrunnen)—Rubinat—Saidschütz—Scarborough Wells—Sedlitz—Stubnya—Tarasp (Great Spring)—Victoria-Ofner.

Simple Soda Waters—Alkaline Waters:

Apollinaris—Bilin—Desaignes (Eau de César)—Fachingen—Fellathal—Geilnau—Gerolstein—Gettysburg—Giesshübel—Kronenquelle—Mont Dore—Neuenahr—Preblau—Salzbrunn—Saint Marco—Soulzmatt—Vals—Vichy—Chaudes Aigues—Evian-les-Bains—Néris—Teinach.

Soda Waters with Common Salt—Muriated Alkaline Waters:

Birresborn—Ems—Gleichenberg—Kainzenbad—La Bourboule (Choussy)—Luhatschowitz—Roisdorf—Royat—Selters—Vic-sur-cère.

Sulphur Waters:

Abano—Aix-les-Bains—Aix-la-Chapelle (Kaiserquelle)—Allevard-les-Bains—Amélie-les-Bains—Ax—Baden (Austria and Switzerland)—Bagnères de Luchon—Barèges—Battaglia—Buffalo Lithia Springs—Builth—Burtscheid—Cauterets—Challes—Eaux Bonnes—Eaux Chaudes—Eilsen—Enghien—Grosswardein—Gurnigel—Harkany—Harrogate (old sulphur well)—Helouan—Heustrich—Kainzenbad (Gutiquelle)—Spring at Kreuth—Langenbrücken—Le Vernet—Llandrindod—Llanwrtyd—Lisdunvarna—Mehadia—Meinberg—Moffat—Nenndorf—Panticosa—Pystjan (Posteny)—Saint Sauveur—Schinznach—Stachelberg—Strathpeffer (upper well)—Töplitz Warasdin—Uriage—Weilbach—White Sulphur Springs (West Virginia, U.S.).

Lime Waters—Earthy or Calcareous Waters:

Alet—Bethesda—Buffalo Lithia—Chateldon—Condillac—Contrexéville—Couzan—Cransac—Inselbad—Johannisbrunnen—Leukerbad (Lorenzspring)—Lippspringe—Lucca—Poland Spring—Pougues—St. Galmier (Source Nouvelle)—Sulis—Taunus—Weissenburg—Wildungen.

Chalybeate Waters:

Arapatak—Alet—Alexisbad—Altwasser—Antogast—Bartfeld—Bocklet (Stahlquelle)—Brückenau—Bussang—Cudowa—Driburg—Elster—Flinsberg—Franzensbad—Freienwalde—Freiersbach—Godesberg—Griesbach—Gonten—Harrogate—Heinrichsbad—Hofgeismar—Imnau—Kainzenbad—Kœnigswarth—Liebenstein—Liebwerda—Lobenstein—Muskau—Niederlangenau—Orezza—Petersthal—Pyrmont—Recoaro—

Reinerz—Rippoldsau—Santa Catarina—Schandau—Schwalbach—Shelfanger—Spa—St. Moritz—Sternberg—Tunbridge Wells—Vichnye—Wiesau—Wildungen.

Iodine Waters.

Arsenical Waters.

Whey and Grape Cures.

Mineral Baths and Wells.

The chief purpose of this section is to mention all the chief natural mineral waters now so commonly resorted to for the improvement or preservation of health, and for the treatment of disease, to note the chief constituents of these waters, and the effects they are supposed to produce, and to indicate the diseases for which they are employed. Mineral springs and wells are now so numerous that it is impossible in the space at our disposal to devote even a few lines of consideration to each. The plan will, therefore, be followed of classifying them according to their chief constituents, which will be to some considerable extent also a classification according to their uses. All the springs and waters which are in use to any extent can thus be arranged in a series of tables, and only the chief of them will be selected for further remark.

Nearly all of the springs are employed for bathing as well as for drinking purposes. In Part II. Section V. p. 732, and subsequent pages, sufficient has already been said regarding baths, and no further special consideration need be given to that subject. The waters which are employed for bathing purposes will, however, be mentioned, and their manner of use indicated as we go along, though the chief object of the section is to consider their effects when imbibed. We must first give some attention to the general effects of water on the body.

The Action of Pure Water on the Body.—By pure water we mean here not water chemically pure, but such water as is ordinarily used for drinking purposes. The nature of such water has been already discussed in Part II. Section II. p. 634. We have seen that the human body consists of water to the extent of 61 per cent (p. 535). Water is necessary to chemical changes going on, and the water removed from the body in the breath, in the sweat, in the urine, and by the bowels is the vehicle, so to speak, by which are removed from the organism the waste products of the chemical actions going forward in the body necessary to continued life and activity. As a general rule, the more active a tissue is, the greater is the amount of water it contains; thus, while bone contains only 48½ per cent of water, the gray substance of the brain contains nearly 86. Within certain limits, therefore, an increase in the amount of water taken will lead to increased activity of tissue change. If we take, for example, the water expelled by the kidneys, we find that, corresponding to an increase in the quantity imbibed, there is an increase in the output by these organs. The water thus expelled is more dilute, contains less substances in solution than an equal quantity of such as was expelled when only an ordinary amount of water was being taken, but if the quantities be collected for 24 hours, it is found that the total quantity of solids removed by the more dilute urine is in excess of that removed by the more concentrated. In short the drinking of an increased quantity of water has caused the removal of more waste from the body. There is a like increase in the waste removed by other channels, the skin, for example. An increase in the quantity of water drunk also will increase the quantities of digestive juices secreted, and to some extent assist the digestion; in particular it increases the production of bile. There is no doubt of its value in the stimulus thus given to removal of waste from the liver, and in the relief thus afforded to that organ.

In the deliberate use of larger quantities than usual of water, there are three circumstances worthy of special attention: (1) the time when the water is taken, (2) the rapidity of drinking—the quantity, in other words, taken at a time, and (3) the temperature of the water. As regards the time, water is more quickly removed from the stomach and passed into the vessels going to the liver when the stomach is empty. On this account the morning, before breakfast, is the time usually chosen. As regards the quantity, if a large quantity is introduced into the stomach at a time, absorption is apt to be slow, and discomfort likely to be experienced. The waters should, therefore, be sipped slowly. The person after sipping one glass walks up and down some verandah or pathway, engaged in pleasant conversation it may be, and in ten or fifteen minutes takes a second glass, and so on till he has consumed an appropriate supply. If he is unable to take as large a supply as is desired at one time, a further quantity may be taken before the midday and afternoon meals. As regards the temperature, waters taken warm, as near as possible to the temperature of the blood, are less stimulating to the stomach and bowels, but the warmth promotes their absorption, and conduces, therefore, to their action on the blood and distant organs. When cold waters produce a loaded feeling of the stomach, this will be overcome by slightly warming them. If the waters are taken with the intention of stimulating the stomach and bowels, not so much for the purpose of being absorbed into the circulation, they are best taken cold. Mineral waters taken, for example, for constipation are best thus, and simple cold water taken on an empty stomach in the morning is often sufficient to secure an aperient action. Ice-cold water, again, is a most pronounced sedative to the stomach, but it must be sipped only in small quantities. Hot water also is soothing, and useful in painful affections. Moreover it stimulates the liver, and is a powerful aid to the removal of bile from the liver, for which, as well as for its general calming effects, it is taken in the evening.

Now if we sum up all these numerous effects of simple ordinary water drunk in early morning at a spa—the cleansing effects on kidney and skin, the increased removal of waste products, the stimulus to increased tissue change, the stimulus to the stomach, the washing out, so to speak, of bile from the liver, the restoration of regular function to the bowels—and if we add to all these the complete change of air and scene, the complete change of occupation, of habits, and of companions, the cessation of hurry and worry, and of the accustomed routine of daily duties, we can easily understand how rapidly beneficial may be a brief stay at a spa, especially to the worn-out man of business or professional worker.

It is due undoubtedly to the circumstances indicated that many spas have obtained their repute; for a large number of the waters, as we shall see, contain no more solids than does ordinary drinking water from lake or river, and they are, therefore, called **indifferent waters**. One ingredient the most of these waters possess, namely carbonic acid gas. Bubbling up from a deep subterranean source, they cannot fail to be charged with such gas, as we have already explained on p. 651. Its effect upon the stomach is largely a mechanical one. The gas given off from the liquid in contact with the stomach walls appears gently to stimulate the circulation in the walls of the stomach, while a soothing effect seems also to be produced on the nerves. Whether that be due or not to the chemical action of the gas, it is not possible to say definitely. It is certain that an aerated water is often retained in the stomach when other materials, plain water among them, are rejected. The stimulating effects of the escaping gas act also upon the bowel, and simple aerated water will frequently prove effectual in constipation when plain cold water, and even purgative mineral waters, have no effect.

The Action of Mineral Waters on the Body.—While many of the spa waters contain no more, and some even less, solids in solution than common drinking water, most of them contain considerably greater quantities of saline material, some of them so much that they cannot be used for drinking or even bathing purposes without dilution. Among the principal ingredients of mineral waters are the following:—

Common salt (chloride of sodium).
Chloride of potassium.
,, magnesium.
,, lime.
Carbonate of soda.
,, potash.
,, magnesia.
,, lime.
,, iron.
Sulphate of soda (Glauber's salts).
,, magnesia (Epsom salts).
,, lime.

Besides these there are phosphates, compounds of bromine and iodine, arsenic, aluminium, strontium, lithium, barium, silicon, fluorine, nitrates, &c., and besides oxygen, nitrogen, and carbonic acid gas, sulphuretted hydrogen, ammonia, and others. A great variety of substances is contained in many mineral waters; and chemists are now able to detect the presence of substances which exist only in infinitesimal quantity. The minute quantity in which many ingredients are present renders it unlikely that they have any effectual share in the action of the water when taken into the system. On the whole, the character and effects of any given water are usually found to depend upon the two or three ingredients which it has in greatest amount. So that when a chemical analysis is placed before one it is comparatively easy to determine what the action of the water is likely to be, and under what circumstances it is likely to be useful. It is true that while chemists can analyse a mineral water, and determine the quantities in which the various ingredients are present, they cannot manufacture a mineral water which will produce the actual benefits of the natural product. But it must be remembered that the best results from the waters are produced at the springs, where a great many attendant circumstances exist which make for health, and that if the natural waters bottled and used at home are not nearly so efficacious as those drunk at their source, it is because of the absence of these other favouring conditions. Further, though the chemist can accurately enough determine to the fraction of a grain the amount of sodium, potassium, magnesium, calcium, chlorine, nitrogen, oxygen, &c., present in a water, he cannot tell with anything like absolute certainty in what manner the elements are combined. Though he knows to a nicety the quantity of chlorine, sodium, potassium, &c., present, it is on theoretical grounds that he determines how much of the chlorine is in combination with sodium as common salt, how much in combination with potassium as chloride of potassium, &c. Therefore arises the difficulty, indeed the impossibility, of producing an exact imitation. In spite of these circumstances it is possible to classify mineral waters according to their chief constituents. Such a classification will have the advantage of at least indicating the chief effects the waters are likely to have on the body.

Classification of Mineral Waters.

I. First of all are the waters which contain so little solids of any kind that the effects they produce are due simply to the pure water itself. These are called **indifferent waters.** They are mostly obtained from warm springs, and they are mostly charged with carbonic acid gas.

II. The next class is of those whose principal ingredient is common salt, chloride of sodium. **Common salt waters, simple saline waters, muriated saline waters,** are all terms for this class. Some of them are warm, some are cold; most contain carbonic acid gas in some quantity.

III. A third class contain as their chief ingredient Epsom or Glauber's salt, the sulphate of magnesia or soda. These are because of their chemical character called **sulphated waters,** because of their taste **bitter waters,** and on account of their action **aperient waters.** Some of them contain one or other of the salts named or both, and no marked amount of other ingredients. Others have also notable amounts of both common salt and carbonate of soda. Hence the latter are sometimes distinguished by being called **alkaline sulphated waters.**

IV. In another class of waters the chief chemical characteristic is due to the presence of carbonate of soda or potash. These are the **simple soda** or **alkaline waters,** resorted to because of their antagonism to acid, in acidity of stomach and bowels, in gout, &c.

V. Other waters whose chief ingredient is also carbonate of soda contain besides common salt with carbonic acid gas. They are therefore called **muriated alkaline waters.**

VI. Then there are the **sulphur waters,** characterized by the presence in solution of that foul-smelling gas, sulphuretted hydrogen, or other sulphur compounds, much resorted to in liver and skin affections, in rheumatism also and gout.

VII. There are waters whose chief ingredient is lime in the form of carbonate or sulphate, as well as magnesia carbonate. These are the chalky, earthy, or **calcareous** or **lime waters.**

VIII. **Iron** or **chalybeate waters** are those in which the quantity of iron present is such as to confer upon the water its chief value for states of poverty of blood (anæmia), &c.

Some waters contain iodine or bromine or arsenic in such quantity, though still minute, as in the estimation of some to be endowed with special properties, and to be worthy of being characterized as **iodine waters, bromo-iodine waters, arsenical waters,** and so forth.

In each of the classes named, omitting the first, the information as to the chief ingredient or ingredients supplied by the name is an indication of the effects the water is likely to have and the purpose for which it may be used, as will be shown in the consideration now to be given to each class.

Routine of Life at a Spa.—The mere drinking of the waters of a spa or the taking of a course of baths is not the whole, not even the half, of the spa cure. To the change of scene, to the freedom from business cares, of which we have already spoken, must be added the strictly regular habits of life, the return to natural modes of living, and the simplicity of diet, which are all essential parts of a proper course of baths or mineral waters at a health resort. No one, who visits such a resort for the restoration of health, thinks of carrying with him the highly elaborate and artificial habits of life out of which he can hardly extricate himself at home. The visitor first of all, on arrival at the spa, consults one of the local physicians who is well acquainted with the action of the waters of the place and knows how to employ them to best advantage in each particular case. He has laid down for his guidance careful rules as to the waters to be drunk, the baths to be taken, the diet to be employed, the exercise to be engaged in, and if he be a wise man he will follow out the directions to the letter. The usual routine is something like the following:—The patient rises at 6 a.m. or earlier, and betakes himself to the spring not later than 7 o'clock. He drinks one glass of the water, and walks for 15 minutes; then he drinks a second glass and again promenades for 15 minutes. A third glass follows and is succeeded by another walk of 15 to 30 minutes or longer, the time taken to return to hotel or lodgings being counted as part of the time. He then rests for half an hour or so, passing the time in agreeable conversation or some light occupation. Breakfast is taken at 9 a.m., a simple easily digested meal, often, as at Carlsbad, nothing more than one or two light rolls and coffee, and it is frequently taken in the open air in the gardens of a *café*. A little time after breakfast a walk or pleasant excursion is the rule, terminating, at any rate, half an hour or more before dinner to permit of rest before the chief meal of the day, which is at 1 o'clock or half-past 1. The meal is varied enough, its exact character being, however, prescribed by the physician. In the afternoon a second course of water-drinking may be prescribed. If so, it is usually between 4 and 5, the first glass being followed by a 15-minutes' walk and a second glass by a walk of half an hour or more. At 7 p.m. or 7·30 a light supper is taken; and the visitor goes to bed not later than 10 p.m. These are the general rules; but, of course, they are subject to variations in accordance with the strength of the individual. Thus while, as a rule, the water is taken on an empty stomach in the morning, if a patient feels too feeble to do so and to take so much exercise without food, he is allowed, before going to the spring, a cup of bouillon, or a glass of milk, or a cup of coffee and a small piece of bread; and many patients add to the waters milk or whey.

Baths are most frequently taken between 11 and 12 o'clock, or between 2 and 4 afternoon, or as near to these hours as can be arranged so that the time for bathing be pretty nearly equidistant between the hours for meals.

At many of the principal spas a long covered way is provided in which patients may take the prescribed amount of walking exercise during wet weather, while the time is made to pass pleasantly by the playing of varied selections of music by the instrumental band, which is one of the invariable accessories of a popular resort. The band plays usually at the spring for an hour or two in the morning, and for a similar time in the afternoon or evening. At Homburg, to suit English habits, there is lunch at 1 or 1·30 p.m., and dinner at 6 or 6·30 p.m. The evening performance by the band begins at 7·30 p.m.; and when the weather is unsuited for out-of-door performance, it takes place in a well-appointed concert-hall. It may be added that a course at a spa is usually prolonged for from three to six weeks, but varies according to the requirements of each individual patient.

Well-fever or **Bath-fever** is a feverish condition which sometimes arises with excessive use of waters or unduly prolonged or too hot baths. Giddiness, drowsiness or sleeplessness, a feeling of cold followed by heat and sweating, rashes on the skin, are some of the symptoms produced, which at one time were regarded as part of the necessary result of the treatment, and the indication of the system being affected by the treatment. Concerning this Braun says: "From the misuse, both as to quantity and temperature of waters taken medicinally, there result in many cases various conditions of indisposition, differing according to the individual concerned, and most unsuitably comprised under the mystical common designation of well-fever. A well-fever does not exist, any more than does a well spirit; and what is generally understood by the term are individual conditions, in consequence of a lasting or transient exaggerated effect produced by the method, diet, and new mode of life, often, of course, combined with excitement of the system, but without common, characteristic, and constant symptoms. Deluging the stomach with water very easily produces dyspepsia and catarrh of this organ; and the special peculiarities of the liquid, its cold or heat, and the different salts and gases contained in it, heighten and modify this influence; digestion suffers, nutrition fails, the skin is subject to various eruptions, especially boils, and from the general state of health the symptoms of the general malady are increased." Waters which contain little or no salts in solution produce such symptoms as readily as strong waters, if their employment is overdone. They are very frequently observed at Buxton and Gastein, whose waters are even purer than ordinary drinking water. These are the reverse of desirable results, and are to be avoided by medical advice being sought and followed in the use of the waters.

I. Indifferent Waters (Simple Thermal Springs—Wildbäder).

There are waters termed indifferent because they possess no particular chemical characters because of absence of solid constituents in any quantity. Some are even purer than ordinary lake or river water, used for drinking purposes.

They are perfectly transparent, and devoid of taste. These waters are very largely used for bathing purposes, the constant supply of hot or warm water from the spring being taken due advantage of, swimming baths being arranged as well as sitz and foot baths, &c. It does not appear that they have effects beyond those due to the warmth of the water. Many of them contain gases in solution, and the escape of the gas in the water is accompanied by a gently stimulating action on the skin. Most of these springs rise at considerable elevations in hilly regions, and on that account have been called wild-baths (Wildbäder), *Aquæ Ferinæ* or *Thermæ Silvestres*, and the mountain climate is to be taken into account in estimating their effects. The waters when drunk have the effects of pure water already described, and they may be taken as hot as possible from the spring or may be allowed to cool.

Such waters are used as baths for their calming and soothing effects, and are found beneficial in nervous cases, cases of neuralgia, hysteria, excitability of the nervous system, sciatica, and painful menstruation. In rheumatic affections and in gout, specially in irritable forms, their soothing effects and their influence in aiding the removal of thickenings and swellings are valuable. But this is not an exclusive property of this kind of bath. In skin affections they are prized. They are employed also in abdominal affections, such as are accompanied by chronic thickenings finding much relief from such treatment. In some forms of paralysis, such as that following diphtheria or consequent upon lead-poisoning, they often produce benefit. Such waters are taken internally to soothe irritability of stomach and bowels, to stimulate the action of the liver and promote the secretion of bile, to correct acidity of the stomach and constipation. In general states of ill-health and in retarded convalescence the waters are useful because of the promotion of tissue change, and the warm baths aid their action. Such baths and waters are also useful to persons who, not suffering from any organic disease, are exhausted and their vital powers lowered by excessive work or the fatigues of ultra-fashionable life. In such cases the well-directed life of the bathing establishment, with its regularity, its quietness, its mountain air, and the calming influences of the warm bath on the nervous system, and at the same time its gently stimulating effects on the skin and circulation, with the change of tissue it promotes in association with the drinking water, are all well adapted to promote a restoration to ordinary healthy activity.

The table No. I., page 926, contains the names of the chief springs whose characters have just been described, their situation, elevation above sea-level, and the temperature of the springs being also noted.

We must now give a few details regarding the more important of these springs.

Bagnères de Bigorre (1850 feet), on the Adour, in the Hautes Pyrénées, is included among the indifferent waters, since it contains barely 10 grains of solid constituents in 16 ounces, of which nearly 6 consist of sulphate of lime, not absorbed if the water is imbibed. It is one of the most popular baths in France. It possesses no less than twenty-four springs, two of which, the Foulon and the Salut, are used for bathing purposes to diminish excitability of the nervous system. Three of the springs contain carbonate of iron, nearly ¾ grain in 16 ounces in one of them, these waters also being at a high temperature. These are used in cases for which iron is suitable (see p. 947). The accommodation is good, and the situation beautiful. It is reached in 5½ hours from Bordeaux.

Bath, in the county of Somerset, England, was at one time a most popular and fashionable resort, and after a period of neglect efforts are being made to restore it to something like its old estate by the provision of every possible aid to the comfort and pleasure of visitors. It has four springs (swimming bath 88°, king's 110°, queen's 112°, hot 118°). The waters are practically indifferent, containing barely 18 grains of solids to the pint, of which 10 are sulphate of lime, 2½ sulphate of soda, 2½ chlorides of sodium (common salt), and of magnesium, and 1⅓ carbonate of lime. A minute quantity of oxide of iron is also present. The waters are recommended for rheumatism and gout, chronic skin diseases, as psoriasis and eczema, dyspepsia, and neuralgia; of the water ½ to 2 tumblerfuls are taken once or twice daily. The advantage of Bath is that it is available the whole year. It affords, indeed, one of the best winter climates in England, and is resorted to rather between November and April than in summer, when it is too relaxing. Its disadvantage is that it is a large town of about 52,000 inhabitants, but the accommodation is in consequence of a wider variety, and its bathing establishments are good.

The mineral water of Bath is bottled for use as a table water under the title **Sulis**.

Buxton, in Derbyshire, England, at an elevation of 1000 feet, has an abundant supply of very pure water, containing only 2¼ grains of solids in 20 ounces of water, with $\frac{1}{2}$ cubic inch of carbonic acid gas, but 60 of nitrogen. Its air is pure and bracing, but the temperature is very variable, and the rainfall rather excessive. The water is chiefly used for bathing, five minutes' immersion in the natural bath, fifteen minutes' if its temperature is artificially raised to 93° or 96°. In chronic gout and rheumatism, especially with debility, it is most useful. Of the water 2 or 3 pints are drunk throughout the day, part an hour before breakfast, the rest early in the afternoon. Buxton is not a very desirable place for the very enfeebled or delicate. The risk of catching cold, owing to the variableness of the climate is considerable; and the hilly character of the situation does not admit of any extent of level walk for the real invalid. The season is from April to November.

I. SIMPLE WARM WATERS (THERMAL SPRINGS).

Name.	Situation.	Temperature in Degrees Fahrenheit.	Elevation in Feet.	REMARKS.
Acqui	Italy	103 to 113 and upwards.		Mud-baths also.
Badenweiler	Baden	69 to 81·5	1,425	Whey-cure also.
Bagnères de Bigorre	France (Pyrenees)	90 to 95	1,850	
Bath	England	88 to 118	100	Contains ·03 gr. oxide of iron in 20 ozs.
Bormio	Italy	90 to 104 and higher.	4,300	Season, May to September. For chronic rheumatism and hysteria. Via Innsbruck, Bozen, Meran, and Stilfserjock.
Buxton	England (Derbyshire)	82	1,000	
Gastein	Austrian Alps	96·8 to 114·8	3,315	
Hammam Meskoutin	Algeria	115 to 213		Season, May to October. For rheumatism, gout, malaria, skin-disease, and old gunshot wounds.
Hammam R'Irrha	Algeria	Hot.		
Hot Springs	Arkansas (America)	93 to 150		
Hot Springs	Virginia ,,	78 to 110		
Johannisbad	Bohemia	86	2,000	
Landeck	Glatz in Silesia	66 to 84	1,400	Season, May to October.
Leukerbad (Leuk, Lœche-les-Bains)	Switzerland	102 to 122	4,600	
Liebenzell	Wurtemberg	71·5 to 77	1,113	Contains $\frac{1}{10}$th gr. carbonate of iron.
Lucca	Italy	100 to 129		Season, June to Sept. For chronic rheumatism and skin-diseases. Contains 7 to 13 grs. sulphate of lime.
Luxeuil	Haute-Saône (France)	65 to 133	1,300	
Matlock	England (Derbyshire)	68		
Néris	France	114 to 125	800	For neuralgia, hysteria, rheumatism, and uterine complaints.
Neuhaus	Styria	95	1,200	Whey-cure pursued here also. Season, May to October.
Panticosa	Spain (Pyrenees)	77 to 92	5,000	The highest bath in Europe. A resort in consumption. Season, July to September.
Pfäffers	Switzerland	100.4	2,115	
Plombières	France	66·2 to 143·6	1,310	
Ragatz	Switzerland	100·4	1,510	
Römerbad	Styria	94 to 98	750	Near Tüffer. For hysteria and chronic uterine disease.
Schlangenbad	Nassau (Prussia)	86 to 90·5	900	Mud-baths also employed here.
Teplitz	Bohemia	99·5 to 108·5	648	
Tobelbad	Styria	77 to 83	1,200	
Tüffer	Styria	95 to 102·2	712	Akin to Schlangenbad and Römerbad. Whey-cure also.
Warmbrunn	Silesia (Prussia)	96·8 to 104	1,100	
Wildbad	Wurtemberg	93·2 to 102·2	1,323	

Gastein (3315 feet) is the chief German spa of the kind we are at present considering. In the Tyrol, thirteen hours' drive from Salzburg, in the midst of mountain scenery, it possesses a high reputation for its bracing climate. Rain is heavy in June, July, and August, and the temperature is variable though never very high, the highest being 86° Fahr. The most appropriate season is from the middle or end of July to the beginning of September. The water contains only $2\frac{1}{2}$ grains of solids in 16 ozs., of which $1\frac{1}{2}$ grains are sulphate of soda, so that it is a very soft water. Its high altitude allows the water to be used for bathing at a higher temperature, less excitement being produced than the same heat of water would cause at a lower elevation.

The duration of the bath varies from ten minutes to an hour, and it is suited for chronic rheumatic and gouty conditions especially in nervous and irritable subjects. Gastein has also a reputation for hysteria, some forms of paralysis and impotence. At **Hof-Gastein**, 500 feet lower, and an hour's distance by the road, more accommodation is obtained, and thither the water is conveyed.

Leukerbad (4600 feet) is situated at the foot of the Gemmi Pass in the canton Wallis, and is reached by a railway journey of six hours from Geneva and a road journey of three hours. The waters are classed as indifferent, though they contain 14 grains of solids to 16 ounces; of which, however, 10½ are sulphate of lime, and 2½ are sulphate of magnesia. The baths are employed chiefly in chronic skin disease, the duration of the bath extending from half an hour to eight hours. The bathers are attired in woollen mantles and capes, and pass the time in the bath playing dominoes and chess, taking luncheon, &c., on boards floated to them. Both sexes bathe together, chiefly Swiss and French. The season is from June to September.

Matlock, in Derbyshire, England, has water of a temperature of 68°, but is chiefly famous for its hydropathic establishment, where the system of bathing with hot and cold water is carried out in a scientific manner, probably unsurpassed anywhere.

Pfäffers and **Ragatz**, in the Swiss canton St. Gall, are an hour's walk from one another. The latter is a station on the railway from Rorschach to Chur, on the way to St. Moritz. The waters of Pfäffers are conveyed to Ragatz in wooden pipes. They are used for both bathing and drinking, and are adapted for nervous affections in women, for gout and rheumatism.

Plombières (1310 feet) is situated in the department of the Vosges south of Nancy, and distant from it four hours by railway, and is in France what Teplitz is in Germany. The waters are drunk to the extent of five to six glasses, are easily borne by the stomach, and are useful in chronic catarrh and painful conditions of that organ. The bathing establishments are commodious, and the surroundings in the way of scenery and amusements are pleasant and cheerful. Rheumatism, chronic joint affections, neuralgia, are also treated. Hot baths continued for some hours are used.

Schlangenbad (900 feet) is situated in a valley of the Taunus. Its railway-station is Eltville, and it is near Wiesbaden and Schwalbach. "It is one of the places best suited for the mild, soothing, and refreshing effect of thermal treatment" (Braun). "It is as picturesque as a place can be on the small scale, with shady alleys and endless forest paths. The baths . . . are beautifully arranged, and I can vouch for their pleasant feeling, though I leave it to the fair sex to vouch for their cosmetic properties. They have a great reputation for quieting and strengthening the nervous system, and are resorted to very much by hysterical ladies, and ladies suffering from functional derangements of the uterine system. Skin complaints are also treated here" (Macpherson). The season is May to October.

Teplitz (648 feet) is on a branch from the railway between Dresden and Prague. It is one of the most frequented baths in Europe, and with its newer suburb of **Schönau** affords a total of 4000 baths daily. The town, which is situated in a broad and pleasant valley, surrounded on all sides by hills, has a population of 16,300; its climate is mild, vegetation is luxurious, and the neighbourhood abounds in interest. The springs are numerous, the chief one containing scarcely 5 grains in 16 ounces, of which 2½ grains are carbonate of soda. The baths are given as hot as can be borne, and are employed for all such purposes as have already been indicated on p. 924—rheumatism, gout, &c.—and have a special reputation for old gunshot wounds. They sometimes induce a feverish condition, attended by skin eruptions (see Bath-fever, p. 924). Mud or moor or peat baths are used here also. The season begins in May.

Wildbad (1323 feet), lies in the Black Forest, south of Carlsruhe, and distant from it a railway journey of two hours. It lies in the pine-clad ravine of the Enz; and has a population of 3200. It "has almost everything that can recommend a place to the English." It can be reached from London by Paris and Strasburg in twenty-four to thirty hours. The accommodation and bathing arrangements are excellent. It also, like Teplitz and Gastein, may be taken as a type of the thermal spring, in its effects in rheumatism, gout, depressed conditions of general health, and so on. Various kinds of paralytic cases are specially to be found here. **Liebenzell** is within 8 miles of Wildbad, and **Teinach**, also with mineral springs, cold, one of which contains iron, is 15 miles distant.

Among other places which possess springs, which contain so little solids as to be fitly included among the class of indifferent waters, are **Clifton**, in Gloucestershire, England, whose water contains 4½ grains to 16 ozs., and is of a temperature of 74° Fahr.; **Mallow**, in Ireland, with water of 69°; **Malvern**, in Worcestershire, England, whose water is pure but cold, and used in painful affections of kidneys and bladder; and **Bristol**, with hot wells (80° Fahr.), whose water contains 5¾ grains to 16 ozs., chiefly sulphate of lime and soda, and over 3 cubic inches of carbonic acid gas.

II. Common Salt Waters (Muriated Saline Waters—Sool Waters).

The waters to be considered under this head are those whose chief constituent is common salt, chloride of sodium, a compound of chlorine with sodium. Similar compounds with potassium, magnesium, and calcium (lime) also occur, the chlorides of potassium, magnesia and lime, but it is the sodium salt that is the most important. Waters rich chiefly in this ingredient are used both for bathing and for drinking purposes. Baths containing this ingredient are in Germany called **sool-baths** (sool-bäder). The chief effect upon the skin is a stimulating one, much more stimulating than simple water. It is for this purpose that sea-bathing is employed in the case of scrofulous children, and others with defective nutrition. The strong stimulating effect upon the skin not only exerts a bracing and tonic effect upon it by improving the circulation in it, but has a secondary effect upon all the functions of the body, quickening their activity and promoting tissue change. The pronounced effect of the addition of salt to water is shown by the fact that a bath which contains salt will have as strongly stimulating an effect upon the skin as much hotter water containing no salt in solution. Waters too rich in this ingredient may stimulate to an excessive degree leading to irritation. The exact degree of stimulation is determined by the quantity of salt in solution, the duration of the bath and its temperature. It appears that 2 to 3 per cent of salt is sufficient, that is 150 to 300 grains of salt in 16 ozs. of water, and that 10 per cent is too strong, and that a salt bath of 95° Fahr. will be as stimulating as one of plain water at 100°·8. When the natural water of the spring is too strong it is diluted, and when too weak it is strengthened by the addition of concentrated waters. When such waters are taken internally they stimulate the walls of the stomach and bowels, and if excess be taken the stimulation passes into irritation, evidenced by vomiting and perhaps purging, and other signs of catarrh of the stomach and bowels. But the waters have far wider effects than these. It must not be forgotten that salt exists in every organ and tissue of the body, and in every fluid and secretion or excretion (see pp. 535 and 541). About 3000 grains are present altogether in the body, 300 of them being ever in a state of coming and going, being expelled from the body with urine, sweat, &c., and being restored with food. Salt appears to have a very powerful influence in promoting the digestion and absorption of certain foods, and in the blood and tissues its presence seems to promote the activity of tissue change. At anyrate an increase in the quantity of salt introduced is soon followed by an increase in the amount of urea expelled, the result of the change albuminous food-stuffs undergo in the body (see p. 539). In a case where no common salt is introduced, it yet continues for a long time to appear in the urine, as if change could not go on without it, and the tissues could store up an extra quantity in case of need. Again, the absence of salt from the food or its presence in deficient quantity leads to serious disturbances of general health. A very important part in nutrition is also played by the chloride of potassium. By experiments with animals it has been shown that the absence of the latter from food, though the former be present in abundance, will be evidenced by feebleness and emaciation of the animal.

These facts are partly explanatory of the circumstance that the drinking, in appropriate quantity, of salt waters will greatly improve the nutrition of the body by its stimulating effects on tissue change. Thus such waters are used for this purpose in gout and scrofula. They are often effective in bloodlessness in women, when iron treatment has failed, and they also aid the absorption of iron. In general ill-health, the result of exposure to malaria, they have often proved useful, and in retarded convalescence from acute disease. Their stimulating effects upon the secretions of stomach and liver and other digestive organs are the cause of their extensive use in dyspepsia, both acute and chronic. For this purpose they should be taken cold, and in such quantity that from 60 to 300 grains of salt are introduced in this way daily. The carbonic acid gas they contain assists in producing the effect. In sluggishness of liver and bowels their employment is attended with benefit, as well as in other congestive disorders of other organs, such as the womb. Some of these waters are famous in the treatment of diseases peculiar to women, notably Kreuznach, and in England Woodhall. In both these waters

II. COMMON SALT WATERS (MURIATED SALINE WATERS).

Name.	Situation.	Altitude in Feet.	Quantity of Common Salt in grains in 16 ounces.	Quantity of Carbonic Acid Gas in cubic inches in 16 ounces.	Temperature of the Water in Degrees Fahr.	Remarks.
Adelheidsquelle	See Heilbrunn					
Baden-Baden	Black Forest	616	14½	1½	114·8 to 154·5	Contains also 2 grs. lime and traces of arsenic and bromine. Season, May to October.
Bex............	Vaud (Switzerland)	1400				Grape-cure establishment.
Bourbonne-les-Bains	France (Vosges)	900	46	18	115 to 147	6 grains lime sulphate.
Canstatt........	Würtemberg	600	16 to 19	19 to 27	63·5 to 69·1	Contains also ¼ gr. carbonate of iron, and 14 grs. lime salts. 4 miles from Stuttgart. Mud-baths and whey establishment.
Cheltenham....	England		74·5		Cold	
Cronthal........	Germany (nr. the Taunus)	500	22 to 27	33 to 40	56·7 to 61·2	Contains also 5 grs. lime salts and a trace of iron.
Dipso or Aedepsos	Greece (Negroponte)		68	2	88 to 162	Also ½ cub. in. sulphuretted hydrogen, 7 grs. of Epsom and Glauber's salts and iodide and bromides.
Droitwich......	England, ...		2·500		Cold	
Dürkheim......	Bavaria (foot of Haardt Mountain)	358	71 to 79	4 to 5	Cold	Grape and whey cure establishments. Contains 15 grs. lime salts and ¼ gr. iron, and iodine and bromine compounds from $\frac{1}{10}$th to $\frac{3}{10}$th grain.
Hall	Tyrol	1700	112	2	Cold	Contains iodine and bromine compounds to nearly 1 grain and a minute quantity of iron. Great repute in scrofulous goitre. Season, May to October.
Heilbrunn (Adelheid Spring)	Bavaria.....	2400	38	13	Cold	Contains nearly 1 gr. iodine and bromine compounds, and $\frac{7}{100}$th iron, and 6 grs. carbonate of soda.
Homburg (Elizabeth Spring)	Central Germany (Taunus)	600	48 to 104	43 to 109	50	Contains 17 grs. lime salts, ⅙th gr. iron. Season, May to September.
Ischia..........	Island, 20 m. from Naples					Season, spring and summer. Whey-cure.
Ischl...........	Austria	1400	223			Whey establishment and mud-baths. Season, May to September.
Iwonicz........	Galicia......		47 to 60	30	Cold	Contains also 8–13 grs. carbonate of soda, and small quantities iodine and bromine. Used as the waters of Kissingen.
Kissingen (Rakoczy Spring)	Bavaria.	590	17½ to 44½	41	Cold	Season, May to September.
Kreuth.........	Between Munich and Salzburg	2911				Salt springs used for baths for irritable and scrofulous subjects. Sheltered situation and still atmosphere. Whey-cure establishment.
Kreuznach....	Rhen. Prus...	286	57 to 108	0	Cold	Season, end of April to beginning of Oct.
Leamington....	England		40 to 60	2 to 3	Cold	Contains also from 32 to 40 grs. Glauber's salt, 20 chloride of lime, and small quantities of iron, bromine and iodine. (See table, p. 934.)
Mergentheim...	Würtemberg	590	51	13	Cold	Contains small quantities iron, 15 grs. Epsom and 21 Glauber's salts, and 10 grs. sulphate and carbonate of lime.
Mondorf.......	Luxembourg	600	67	1	77	Contains 12 grs. indigestible sulphate of lime, and 24 of chloride, and ·002 arseniate of soda.
Nauheim.......	Hesse-Darmstadt	450	109	15	72	Contains 11½ grs. bicarbonate of lime, and ·2 carbonate of iron, ·004 arsenic, ·3 bromide of magnesium, and 8 chloride of lime. Other stronger springs used for bathing.
Neuhaus.......	nr. Kissingen	700	76	33		
Pyrmont (Salt Spring)	Waldeck....	404	54	23	Cold	Contains also sulphate of magnesia 7 grs., sulphate and carbonate of lime 16 grs. (For iron springs at Pyrmont, see Table VIII.) This spring is suited for drinking.
Rehme Oeynhausen	Westphalia (betw. Minden and Cologne)	134	240	18	80 to 93	Very fine modern baths, gas baths, &c. Waters too strong for drinking. 22 grains lime sulphate.
Reichenhall....	Bavaria	1407	23 per cent		57	Strongest salt spring in Europe used for bathing. For drinking 1 to 1½ oz. in glass of water. Whey establishment. Has an inhaling chamber, air impregnated with salt spray, useful in catarrh of chest and stomach. 32 grains lime sulphate.
Saratoga (Empire Spring)	U.S.A.........		50½	34½	Cold	
Schmalkalden..	Hesse.......	1000	71	8	Cold	Contains also 22 grs. lime sulphate, making it less suitable for drinking. Mud and pine baths.
Soden.........	Nassau (Taunus)	446	18 to 117	30 to 48	Lukewarm	Whey cure.
Soden..........	Near Aschaffenberg	440	40	0	Cold	The spring for bathing contains 160 grs. salt in 16 ounces.
Thermia (Island)	Greece......		51½	3	116	Contain also bromine and iodine and 9 grs. Epsom salt.
Wiesbaden....	Nassau......	323	52½	6½	156	
Wildegg........	Switzerland	1100	75			13½ grains sulphate of lime make it indigestible.
Woodhall.....	Lincolnshire, England		120			Contains ½ gr. bromide and ¼ gr. iodide of sodium.

there is present a small quantity of iodine or bromine or both, and to it the curative effects have been attributed. It is generally believed, however, that the undoubted benefits of such waters in inflammatory and congestive conditions of the uterine organs are the result of the stimulating effects of the salt water and not of the minute quantities of the other ingredients, and we shall, therefore, include them in the present group. By virtue of their stimulating tissue change they aid in removing enlargements from joints and from other parts of the body where inflammation has been accompanied by thickening of parts. The baths are most valuable aids to the waters in cases of weakness of the skin and convalescence from disease. Care must always be taken that excess is not drunk and dyspeptic symptoms set up by this means.

Baden-Baden (616 feet) is situated in the Grand-duchy of Baden, Germany, in a beautiful valley of the Black Forest, easily reached from Frankfort or Strasburg. It is a most popular pleasure resort, with a warm climate, the mean annual temperature being 48°, sheltered by its situation, and with abundant accommodation for visitors, of whom there are more than 4000 annually. Four of its chief springs have been united by shafts, executed under the government of the duchy. The baths are the chief means of treatment employed, but the waters, from their small amount of solid constituents, a total of 22 grains in 16 ounces, are suitable also for drinking. This is at the same time a small quantity for bath purposes, producing little more effect than the simple waters. Slight forms of gout, rheumatism, and scrofula, catarrh of stomach, and congestion of abdominal organs are benefited by Baden-Baden, while persons merely requiring change of air and relaxation without having anything specially wrong with them could not, according to Dr. Macpherson, go to a better place. Two of the springs, the Murquelle and the Fettquelle, contain appreciable quantities of lithia, and arsenic is also present, but whether they have any effect on the body is not known. The season is from 1st May to 31st October, but is at its height from the end of August to the middle of October.

Bourbonne-les-Bains (900 feet), the French Wiesbaden, is in the department of the Haute-Marne, near the station Laferté, on the Paris-Muhlhausen line. Besides the common salt and carbonic acid, as indicated in Table II., the waters contain 14 grains (to 16 ozs.) of lime salts, and a third of a grain of bromide of sodium. It is one of the stronger saline springs, suitable for such cases as have been noted in the general description of the uses of salt springs. Ague, tumours of the spleen due to malaria, and cases of torpid liver are especially the cases for Bourbonne. Two pints is the quantity of water usually drunk, in association with the baths.

Cheltenham, in the west of England, is mentioned in this group because of one spring, in which the chief ingredient is common salt, though it also contains 11¾ grains of Glauber's salt (sulphate of soda), entitling it to be placed among the bitter waters (p. 934).

Droitwich water has a very large quantity of saline ingredients, 39 grains of Glauber's salt and 38 sulphate of lime, besides the common salt mentioned in the table. It is used only for bathing in chronic rheumatic and gouty conditions, chronic skin eruptions, in lumbago and sciatica, and as a stimulant for the removal of thickenings. The waters are used diluted for the baths at a temperature between 95° and 112°.

Homburg is one of the most popular and one of the most English bathing resorts of Europe. It is a town of 8000 inhabitants, situated on an elevated ridge, and is amply provided with parks, gardens, and shady walks. Its visitors number over 11,000 annually. It is reached by railway from Frankfort-on-the-Main in half an hour. Its waters are used for bathing, for which they are heated, and for drinking. It has five springs, Elizabethenbrunnen, Luisenbrunnen, Kaiserbrunnen, Ludwigsbrunnen, and Stahlbrunnen. The first is chiefly used, and its composition in detail is as follows according to Fresenius:—

Common Salt (Chloride of Sodium),	75·7	grains	in 16
Chloride of Potassium,	2·6	,,	,,
Chloride of Calcium,	5·28	,,	,,
Chloride of Magnesium,	5·6	,,	,,
Sulphate of Lime,	0·1	,,	,,
Carbonate of Lime,	11·6	,,	,,
Carbonate of Magnesia,	0·2	,,	,,
Carbonate of Iron,	0·18	,,	,,
Carbonic Acid,	45	cubic inches.	
Temperature,	50°	Fahr.	

The last-named spring—Stahl—is more strongly iron than the others; while the Ludwigsbrunnen is the weakest and pleasantest drinking water. The Elizabeth spring has an opening effect on the bowels after three glasses, and the waters are employed in congestions of abdominal organs, and are specially useful in gout, rheumatism, and dyspepsia, and to those indisposed after a winter's round of gaieties, and to the overworked professional or business man. The more pronounced iron springs are suitable in persons debilitated by Indian heat. The bathing accommodation has of late been greatly increased; and the Kaiserbrunnen is chiefly used for the baths.

Ischia, a volcanic island at the northern corner of the Bay of Naples, has no less than 14 springs all more or less warm, the chief, Gurgitello, having a temperature of 158° F., and containing 135 grains of solids in 16 ounces, chiefly salt and carbonate of soda, charged also with carbonic acid gas. They are used in gout, rheumatism, paralysis, scrofula, skin diseases.

Ischl (1400 feet) lies in the valley of the Traun in Austria, in the Salzburg district, the nearest station being Gmunden. Its high situation and hilly surroundings confer upon it a mild equable climate, and it is specially sought in chest affections. There is excellent accommodation, a well managed hotel, and a hydropathic establishment. The waters are used for bathing, being diluted for the purpose.

Kissingen lies in the valley of the Saale, North Bavaria, six hours' railway journey from Frankfort. It is a popular resort, the visitors numbering over 13,000 annually, and there is abundant accommodation suitable for various lengths of purse. The surroundings are both interesting and beautiful. It has numerous springs, typical of the salt springs we are considering. Three of them are used for drinking, Rakoczy, Pandur, and Maxbrunnen, and others for bathing, Soolsprudel in particular. The composition of Rakoczy and Maxbrunnen in detail is as follows:—

	Ingredients in grs. per 16 ozs.	
	Rakoczy.	Max-brunnen.
Chloride of Sodium (Common Salt), ...	40·75[1]	... 17·52[2]
Chloride of Potassium, ...	2·00	... 1·14
Chloride of Magnesium, ...	2·12	... ·51
Chloride of Lithium, ...	·14	... ·004
Sulphate of Magnesium, ...	4·11	... ·00
Sulphate of Lime, ...	2·72	... 1·06
Carbonate of Magnesium, ...	·11	... ·00
Carbonate of Iron, ...	·22	... ·00
Carbonate of Lime, ...	7·42	... 4·62
Phosphate of Lime, ...	·04	... ·03
Silica, ...	·09	... ·07
Nitrate of Sodium, ...	·06	... ·65
Bromide of Sodium, ...	·05	... ·00
Carbonic Acid Gas, ...	41 cub. in.	41 cub. in.

These tables exhibit the composition of the stronger and of the weaker drinking water. The former is generally taken in the morning to the extent of three to six glasses. The Pandurbrunnen resembles Rakoczy, but contains more gas. The small quantity of sulphate of lime is noticeable and advantageous, because it is not absorbed. The water of Maxbrunnen is used as an ordinary table water. The waters of Kissingen are suitable for all cases for which salt waters are employed (see p. 928). The Soolsprudel, used for bathing, contains 2 per cent of salt, and 30½ cubic inches of gas to 16 ozs., and when the water is heated the amount of gas given off is so great that giddiness and difficulty of breathing are commonly experienced, because of its inhalation.

Kreuznach lies in the valley of the Nahe within an hour by rail of Bingen on the Rhine. Its climate is mild in early spring and late autumn, but hot in summer. It has a high reputation for the treatment of scrofula, more patients of that kind being found here than at any other spring, as well as for affections of the womb. Its effects were believed to be due to the iodine and bromine in the water, but are, according to Braun, rather to be attributed to the drinkable character of the springs, the climatic conditions, the agreeableness of the place, and the well adapted method of treatment. "Kreuznach is a typical model as regards the mode of treatment and the internal and external application of Sool-springs." The chief spring used for drinking is the Elisenquelle, which has the following composition in grains per 16 ozs.:—

Common Salt, ...	72·88
Chloride of Lime, ...	13·39
Chloride of Magnesium, ...	4·07
Chloride of Potassium, ...	·62
Chloride of Lithium, ...	·61
Bromide of Magnesium, ...	·27
Iodide of Magnesium, ...	·03
Carbonate of Lime, ...	1·69
Carbonate of Magnesium, ...	·10
Carbonate of Iron, ...	·15
Silica, ...	·13

Of this water 4 ozs. are usually drunk to begin with, and the dose increased to 20 or even 30 ozs. There are several other springs, Oranienquelle, Carlshalle, Theodorshalle, and Münster-am-Stein, of which the first contains 108 grains of salt in 16 ozs., and the last only 60. In association with the drinking water, baths are systematically used, taken about an hour after drinking, at a temperature of about 90° to 92°. At first the bath lasts for a quarter of an hour, but is increased to three-quarters; and the water for the bath is strengthened by the addition of "mother-lye." To this combination of strong salt baths with the weaker drinking water Braun attributes much of the beneficial effects produced. The quantities of iodine and bromine are too small to be credited with them. The cases for which Kreuznach has greatest repute are those of scrofulous swellings, the stimulation of the salt baths and the action of the water in promoting tissue change leading to their absorption. The water also increases the secretion from the bowels. In congestion, chronic inflammation, and thickening of the womb and other abdominal organs, in similar affections of the breasts, and in cases of painful monthly illness connected with similar conditions, they are most valuable, as well as in the other diseases indicated in the early paragraphs on salt waters.

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[1] Tichborne's analysis, 1883.

[2] Liebig's analysis.

Soden, a town of 1500 inhabitants, lies at the foot of the Taunus range, and is half an hour's journey by rail from Frankfort. It has a warm equable climate, somewhat moist, and has long been much resorted to in conditions of chronic catarrh of the lungs, consumption, and disorders of the abdominal organs. Spring, late summer, and autumn are the best times for a visit, as the heat, owing to its sheltered situation, is often oppressive in summer. About 1300 feet higher on the slope of the mountains is **Falkenstein**, which is much more bracing, though well sheltered from the north and east, and more suited for chest diseases. Soden has no less than twenty-three springs with varying quantities of common salt, but none of them with sufficient to make them very stimulating. Some of the wells contain ·2 to ·3 grain iron.

Wiesbaden, a town of 50,000 inhabitants, is the capital of Nassau, five miles north-west of Mayence, and has annually upwards of 60,000 visitors, to whom it offers all variety of accommodation. It lies in a valley exposed to the south only. Its winter climate is not severe, and in summer it is intensely hot, so that early spring or late autumn is a very suitable season. Many of the hotels have baths supplied direct from the springs, of which there are seventeen, from which the water issues warm. The water is abundant, and all is used for bathing, but only one source, Kochbrunnen, is used for drinking. The quantity of solids dissolved is so little comparatively, that the baths have the effect of little more than simple warm waters, though they are not to be used in irritable skin eruptions and eczema. They are useful for gout, rheumatism, and paralysis. Wiesbaden is "one of the most beautiful, amusing, and effective baths, rivalled but by few in its ability to satisfy all requirements, both the simplest and the most complicated, and in the excellent arrangements for the use of its waters."

The composition of the water is as follows, in grains per 16 ozs.:—

Common Salt,	52·49
Chloride of Potassium,	1·19
Chloride of Ammonium,	9·12
Chloride of Lime,	3·61
Chloride of Magnesium,	1·56
Chloride of Lithium,	·001
Sulphate of Lime,	·69
Carbonate of Lime,	3·21
Carbonate of Iron,	·04
Arseniate of Lime,	·001
Bromide of Magnesium,	·027
Carbonic Acid,	6½ cub. in.
Temperature,	156° Fahr.

It is pointed out that the drinking of such water as the above in a warm condition, and with its small amount of gas, results in the water being absorbed and passing through the body, promoting tissue change. Whereas a cold water with the same quantity of salt and more gas would stimulate stomach and bowels, producing increased activity of the bowel. All the diseases indicated on p. 928 are treated by the Wiesbaden water, and specially gout and rheumatism.

Woodhall, near Horncastle in Lincolnshire, England, has of recent years come much into repute for the treatment of rheumatism, scrofula, and uterine complaints. Its value is ascribed to the iodine and bromine it contains, and it is called the "Iodine Spa." Braun, however, believes the effects to be due to the common salt and other conditions. A recent analysis of Professor J. A. Wanklyn indicates also the presence of *free* iodine, an observation of importance, as a very minute dose of *free* iodine would yet have marked effects, and it may be that the undoubtedly beneficial influence of the water is due, to some extent, to this ingredient. The analysis in 16 ounces is as follows:—

Common Salt,	133	grains.
Chloride of Lime,	11·1	,,
Chloride of Magnesium,	9·1	,,
Carbonate of Soda,	1·0	,,
Sulphate of Soda,	·03	,,
Nitrate of Soda,	·05	,,
Free Iodine,	·02	,,
Iodine as Iodates,	·02	,,
Iodine as Iodides,	·04	,,
Bromine as Bromides,	·34	,,
Iron,	traces.	

Much has been done by the building of a well-equipped bathing-house, hotel, &c., to make the place pleasant for visitors, and in Woodhall there now exists for English invalids a rival to Kreuznach.

In America there are the **Saratoga Springs**, of which the Empire Spring has 50½ grs. salt in 16 ozs., with 16 grs. bicarbonates of magnesia, soda, and lime, ·07 iron, traces of sodium and bromine, and 34½ cub. in. of carbonic acid gas.

Bad-Nauheim, in Hesse-Darmstadt, has of late years sprung into prominence because of the value of its waters in the treatment of chronic heart affections. The observations of the late Dr. August Schott, and the writings of his successor and brother, Dr. Theodor Schott, have made the place famous for these conditions, and the system of treatment initiated by them is called **"The Schott Treatment of Chronic Heart Affection"**.

Bad-Nauheim is a little town of barely 4000 inhabitants, nestling at the foot of a spur of the eastern slope of the Taunus Mountains. It is on the main line of the Hamburg-Hanover-Cassel-Frankfort railway, a run of about forty minutes from Frankfort. It is a nine hours' journey by express train from Hamburg; and there is through service from the Hook of Holland through Rotterdam and Cologne to Frankfort, from Flushing through Cologne, and from Calais through Brussels and Cologne, the through journey from London taking about nineteen hours. It lies at an elevation of about 450 feet above the level of the sea, and the atmosphere is dry though not exactly bracing. Homburg is distant fifteen miles across country. The Spa belongs to the Grand Duchy of Hesse-Darmstadt, and the administration has done much for the visitors who now throng to it in thousands annually. It has the usual attractions of a handsome Kur-haus, well laid-out park, and daily band performances during the season, which begins about the middle of May and lasts till October. It possesses in all six springs, two of which are used for baths, and four for drinking purposes. The baths, however, are the chief agents in treatment, much less importance being attached to drinking the waters.

The chief saline ingredients of the bathing water are common salt and chloride of calcium; the waters are exceptionally rich in carbonic acid gas; and the temperature is only a few degrees below blood-heat, between 89° and 96° Fahrenheit. One spring is named Friedrich-Wilhelm's (or No. 12), and the other "Great Sprudel" (or No. 7), and the principal details of their composition are given in the following column. It will be noticed from the analysis that No. 12 is richer in common salt, containing about 3 per cent, richer in chloride of calcium, contains less carbonic acid gas, and is of higher temperature than No. 7, but the higher temperature causes the gas to come off more rapidly. Each of these springs discharges through a pipe, opening freely into the air, and carried a considerable distance vertically into the air. Round each pipe is built a reservoir, and the water escaping from the pipe, falls back into the reservoir. The reservoirs are quite open to the atmosphere; much of the carbonic acid gas, therefore, escapes, and with the escape of the gas certain salts of iron it helped to keep in solution, are precipitated out, and the water, which, as it comes from the spring, is perfectly transparent, becomes of a muddy, rusty colour. The quantity of gas dissolved in the water is so great that it drives the water out of the pipe with great force, so that it springs into the air to a distance of 40 or 50 feet, in much the same way that, were the cork removed, a soda-water bottle would drive its contents into the air. These tall, straight columns of foaming water, constantly rising into the air day and night from year's end to year's end, are a very remarkable spectacle. The reservoirs are built in the park, and in the immediate neighbourhood are the bath-houses, six in number, capable of accommodating at one time between 200 and 300 bathers.

	Spring No. 12. (percentages.)		Spring No. 7. (percentages.)
Common Salt, ...	2·929	......	2·182
Chloride of Calcium, ...	·232	......	·170
Chloride of Potassium, ...	·111	......	·049
Chloride of Magnesium, ...	·052	......	·044
Bicarbonate of Lime, ...	·260	......	·235
Free Carbonic Acid Gas, ...	·197	......	·237
Temperature, ...	95·54° Fahr.		88·88° Fahr.

There are also small quantities of bromide, iodides, iron, arsenic, &c.

Broadly speaking, there are three kinds of baths in use at Nauheim. I. The mildest bath is of water drawn from the reservoir, which has lost, therefore, much of its gas, which may have its temperature raised or lowered by the addition of hot water or ice, and which may be varied in strength by the addition of "mother-lye". (There are salt works in Nauheim, in which the unused water is concentrated and from which the common salt is removed, the remaining liquid is the mother lye, and this evaporated down yields bath-salt, rich in chloride of calcium, and used for making artificial baths.) II. The second kind of bath consists of water carried directly from the spring to the bath tub by a branch pipe, without previous exposure to the air. It contains the normal quantity of gas; and the water foams and bubbles as it enters the bath-tub. This bath is highly effervescent and is a peculiarity of Nauheim.

III. In the third kind of bath, the water is not turned off when the tub is full, but an overflow pipe is opened, and the patient lies in the bath while the foaming water streams through it. This is called a current-bath (strom-bad). Each of these three varieties of baths may be given with water from either of the two springs. and the springs may be mixed in the one tub, so that a great variety of bath may be given, according to the requirements of the patient.

The baths are used for a great variety of disorders—rheumatism, in its manifold forms, gout, disorders of the heart and circulation, nervous diseases and diseases of women, chronic inflammatory affections and the thickenings that accompany them. But it is for the treatment of heart affections that the waters have become famous. The saline ingredients of the waters stimulate the skin, and the carbonic acid gas forming in fine bubbles on the surface of the body, and constantly escaping from it to be replaced by fresh bubbles, maintains and accentuates this effect on the blood-vessels and nerves of the skin. A patient entering the bath, which is a few degrees below the temperature of the body, feels the water somewhat cold, and there is often a sense of oppression and constriction of the chest. This feeling lasts only a moment, and then a delightful sensation of warmth and comfort steals over him because of the action of the water on the blood-vessels of the skin. The blood is brought to the surface, so that after even 20 minutes' immersion the patient comes out of the bath warm and comfortable, the skin universally pink. The blood being thus brought to the surface, congestions of deep organs are relieved, and the absorption of inflammatory products promoted, while the action of the minute bubbles of gas on the terminal nerves of the skin acts reflexly on the nervous system, and through it on the heart, whose action is strengthened, slowed, and regulated. It is, therefore, weak and dilated conditions of the heart that are suited, *par excellence*, for this treatment, though all forms of heart disease benefit.

The "Schott Treatment" combines the uses of the baths with a system of muscular exercises with resistance, to give which there are in Nauheim men and women specially trained. The exercises consist of movements of flexion and extension of the limbs and of the trunk. For instance, the patient extends both arms straight in front of him, palms against one another. From this position he moves the arms outwards from the middle line till they are straight out from the side and in line with the shoulder. This is done very slowly, and without jerk, the patient breathing quietly and steadily all the time. The operator, standing in front of the patient, places the palms of his hands on the outside of the patient's wrists, and gently resists the movement. The operator holds the patient's arms in this position for a moment, and then the patient brings the arms forward again to the middle line, the operator resisting. The art of the operator consists in getting the patient to perform the movements quite slowly and steadily, without holding the breath, and in adjusting the resistance, which is never great, to suit the patient. To perform another of the movements the patient lets his arm hang down straight at his side, and then slowly bends the forearm on the upper arm, and straightens it again, the operator resisting meanwhile. Between each movement the patient is made to rest a few seconds. The exercises are given to the patient standing, by preference, but the patient may be seated, or even lying down. There are some half-dozen such movements for the arms, several for the legs, and others for the trunk, all of them being resisted in a particular way, and to a carefully regulated degree, by the operator. The effect of these movements, when properly adjusted to the individual case, in strengthening and slowing a weak and irritable heart can be watched by observing the pulse.

To this treatment may be added that of graduated hill exercise (terrain-kur), somewhat after the system of Oertel, of Munich. A variety of other remedial agents, common to many spas, may also be brought into operation at Nauheim, such as the whey cure, grape cure, &c.

By the use of common salt and chloride of calcium (or the Nauheim bath-salt), with acid and soda to produce effervescence, an artificial Nauheim water can be prepared anywhere, and the Schott system of treatment followed away from Nauheim. Such artificial Nauheim baths are now made use of in Bath in England and in Buxton, and may be employed by any physician anywhere.

As a result of his observations during portions of two seasons spent at Nauheim, and of the use in private practice of the artificial baths in a large number of cases, the author is convinced that no other form of treatment offers so great prospects of benefit in many disorders of the heart in which the routine treatment by rest and heart tonics has proved unsatisfactory or of merely temporary benefit.

Waters of kindred properties to those of Nauheim are to be found in Rehme-Oeynhausen, in Westphalia, and in Bourbon-Lancy in the department of Saone-et-Loire, France.

III. Bitter Waters—Aperient Waters—Sulphated Waters.

The chief ingredients of these waters are sulphate of magnesia, commonly called Epsom salts, from the once popular well at Epsom of which it was the principal constituent, and sulphate of soda or Glauber's salt, because it was first discovered and described by Glauber in 1658. The action of these salts has been sufficiently described on pp. 862 and 863. They produce, when given in sufficient doses, a profuse watery secretion from the bowels; indeed, in large doses they produce a catarrh of the bowel, and consequently their frequent use in *large* quantities is not desirable. A glance at the table will show that many of these mineral waters contain little of importance beyond the sulphates of magnesia and soda, while others contain, besides fair quantities of common salt, carbonate of soda and carbonic acid gas. The addition of these other ingredients is of considerable significance. A water which contains them will have with less of the sulphates an opening effect equal to one richer in the sulphates but without these additional constituents. Even carbonic acid gas alone, in addition to the Epsom and Glauber's salts, is a great advantage because of its tonic effect on the mucous membrane, so that a weak aerated bitter water will be of equal value with a strong non-aerated bitter water, so far as its aperient effect is concerned, and will be less likely to occasion disturbance. The same thing is true of the common salt and the carbonate of soda. Some of these waters contain iron besides the other constituents named, notably Marienbad, Carlsbad, Franzensbad, and Tarasp. One may, therefore, perceive how much more beneficial such natural and complicated waters are than a simple draught of Epsom or Glauber's salts artificially prepared. Further, Glauber's salts are milder in action than Epsom, and waters containing them rather than the latter are preferred, Carlsbad for example. Of the simple aperient waters, Püllna, Saidschütz, Sedlitz, Birmensdorf, Hunyadi Janos, and Friedrichshall are the chief; and of those which contain also carbonate of soda, as well as common salt, Carlsbad, Marienbad, Tarasp, Franzensbad, Elster, and Bertrich are the principal. Aesculap, lately introduced in bottled condition, belongs to the latter class, and so also does Mattoni's Royal Hungarian Bitter Water.

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The chief use of these waters is in sluggish conditions of abdominal organs, in constipation, in congestion and enlargement of the liver, in piles dependent upon such states of the liver, in gall-stones, and in enlarged spleen. They are specially beneficial for persons of a too full habit of body, specially when such a condition is largely due to excess in diet and deficient exercise. The action of the waters on the bowels stimulates tissue change, and is a direct incitement to the removal of deposited fat, so that such persons lose some of their superfluous bulk, while they do not become weakened or less vigorous muscularly, under a judiciously directed course of the waters. In indigestion consequent upon sluggish circulation in the bowels, they are also useful. In some cases of gout, also, they are valuable, as may readily be understood from what has been said, and also in gravel. Some of them, specially those rich in carbonate of soda, such as Carlsbad, are made use of in diabetes with some benefit.

Aesculap is obtained from springs at Buda-Pest, in Hungary, and is bottled for use. It is an excellent aperient in doses of a wine-glassful to a tumblerful, with an equal quantity of hot water.

Carlsbad, in the Eger district of Bohemia, in a narrow valley, nearly 1200 feet above the sea-level, is a town of 12,000 inhabitants. The river Tepl runs through the valley, and the town is built on both sides. High and steep hills rise on either hand, the pine-clad slopes of which are rendered accessible by paths cut in all directions. The municipality has purchased 30,000 acres of pine-wood, which are laid out in mile upon mile of carefully-kept walks, and supplied at frequent intervals with seats for the sake of those pursuing the exercise-cure. A series of garden restaurants are set up, where visitors can breakfast or dine beneath the trees. Everything possible has been done by the municipality to attract and add to the comfort of visitors, even to the establishment of an official band, which, it is said, has few rivals in any great city. The number of visitors is 25,000 yearly. The springs are numerous, and differ little in their constituents, but vary in temperature and in the amount of dissolved gas. The chief is the Sprudel, situated in the centre of the town, over which has been erected a glass-domed building. It rises with a throbbing movement 4 or 5 feet in the air, falling back into an ornamental basin, round which stand girls who fix the glasses of the visitors on to the end of long rods and dip them into the cauldron. The temperature of the water is 162° F., and a cloud of steam fills the building. Chief of the other springs are the Mühlbrunnen, the Schlossbrun, the Hygeiaquelle, and Theresienbrunnen. The composition of the Sprudel is as follows, in grains per 16 ozs.:—

Sulphate of Soda, ...	19·8
,, Potash,........	·4
Common Salt, ...	8·5
Carbonate of Soda, ...	14·2
,, Lime,........	2·0
,, Magnesia,..	·3
,, Iron,.........	·02
,, Lithia, ...	·08 (Tichborne).

The waters are drunk early in the morning before breakfast, from 2 up to 8 or 10 glasses of 6 to 8 ounces each being slowly imbibed, exercise in the open air being at the same time engaged in. This usually produces a slight opening effect. About an hour after the last glass a light breakfast is taken. Dinner is at 1 o'clock. A cup of coffee is allowed in the afternoon, a light supper at 8, and 9 o'clock is the recognized hour of retiring to bed. The diet is very carefully regulated by the physicians, the meals being very plain but well cooked. Meals may all be taken in the open air, and there is no such thing as *table-d'hôte*. The Carlsbad cure

III. BITTER WATERS

(Sulphated Waters, Waters whose Chief Ingredients are Sulphate of Soda and Magnesia).

Name.	Situation.	Elevation above Sea-level in Feet.	Amounts of Chief Ingredients in Grains per 16 ozs.				CO_2 * in Cubic Inches per 16 ozs.	Remarks.
			Sulphate of Magnesia (Epsom Salts).	Sulphate of Soda (Glauber's Salts).	Common Salt.	Carbonate of Soda.		
Aesculap	Hungary		175	134	30	14		⅓ gr. iron.
Bedford Springs....	Pennsylvania (U.S.A.)		3·2	2·6				9 grs. sulphate of lime.
Bertrich	Near Coblentz ..	500	0	7	3	1½	4½	Warm spring.
Birmensdorf	Canton Zurich (Switz.)		169	54				
Carlsbad (Sprudel)	Bohemia	1,200	0	20	8½	14	12	Warm spring. Small quantity of iron.
Cheltenham (Pitville water)	England		0	11¾	48	2	1½	
Elster	Saxony	1,460		24	8	7	16	⅓ gr. iron.
Epsom			240					
Franzensbad (Franzensquelle)	Bohemia	1,569		25	9	8	40	Iron also.
Friedrichshall ...	Saxe-Meiningen	920	64·1	71·5	99·7	Carbonate of magnesia, 2·1	9	Chloride of magnesia, 50·1, 17 grs. lime sulphate (Tichborne).
Füred	Hungary			6	$\frac{7}{10}$	1	38	6 carbonate of lime and ·08 gr. iron.
Hunyadi Janos ...	Hungary	460	156	158	10½	5		Tichborne's analysis.
Leamington (Saline Spring)	England			28·7	68·8		1½	Season May to October.
Marienbad (Kreuzbrunnen)	Bohemia	1,980		32	10·1	11·4	15	$\frac{1}{10}$ gr. of iron.
Mattoni's Royal Hungarian Bitter Water	Hungary		122	101	20	13		·6 gr. iron and 10 lime sulphate.
Mergentheim	Würtemberg	591	16	22	51¼	Carbonate of lime and magnesia, 6·8	7½	10 grs. sulphate of lime, ·05 iron.
Ofen or Buda	Hungary	461	0	3	¾	2	5½	Warm 140° F.
Pullna	Bohemia		66·3	88	Chloride of magnesia, 12½	Carbonate of magnesia, 5½	2	2 to 6 grs. lime sulphate.
Purton	Wiltshire (England)		23		4·2	Carbonate of potash, 3½	6	10 grs. lime sulphate.
Rohitsch (Tempelbrunnen)	Styria	730		15½	$\frac{7}{10}$	6	25	Carbonate of lime and magnesia 21, iron ½ gr.
Rubinat............	Pyrenees (Spain)		5	148½	3			Dose, ½ to 1 wineglassful.
Saidschütz	Bohemia	660	84	46	2	Carbonate of magnesia, 5	0	10 grs. of indigestible sulphate of lime.
Scarborough Wells	Yorkshire (England)		17 to 28		3½		0	
Sedlitz	Bohemia		104	0	3	3	0	8 grs. lime sulphate.
Stubuya	Hungary			4			3	Hot, 111° F.
Tarasp (Great Spring)	Lower Engadine (Switz.)	4,608		16½	29½	38½	33	⅕ gr. iron. See p. 796.
Victoria-Ofner	Buda-Pest		229½	120	12	8		16 grs. lime sulphate.

* CO_2 = Carbonic acid gas.

is not only a water-cure, but also a diet-cure, an air-cure, an exercise-cure, and a rest-cure. The cases suited for Carlsbad are dyspeptic cases, cases of catarrh of stomach and chronic ulcers of the stomach and catarrh of bowels, of enlarged and fatty livers, of enlarged spleen, cases in which there is a tendency to gall-stones and biliary disorders, gout, and catarrhal conditions of the kidney and urinary organs. The lean dyspeptic ill-nourished man seeks Carlsbad to get rid of his dyspepsia and to put on fat, and the fat man seeks it to stimulate his tissue change and put off some of his fatness. Improvement is also observed here in many diabetic cases. The waters are also used for baths. The season begins in May, and August and September are found very pleasant months there. The bottled water should be used before breakfast and with exercise if possible, either 2 or 3 glasses warmed to 100° Fahr., with an hour's exercise before breakfast, or a milder course of half a tumblerful warmed, sufficient to secure a gentle motion. About 3,000,000 bottles of the water and 90,000 pounds of the salt are exported annually.

Cheltenham possesses several springs, one whose chief ingredient is common salt, mentioned in Table II., another, the Pitville spring, is placed in the present list of bitter waters. There are others which contain iodine and sulphur, and one strongly iron spring which will be noted later. Braun says concerning them that their chief defect is the small quantity of carbonate of soda and carbonic acid, but that this might be remedied by the addition of a certain quantity of Bilin or Fachingen or Vals water, and they might be heated to a suitable temperature. They are much used for liver affections in dyspeptic persons.

Elster (1460 feet), on the Bohemian frontier, between Plauen and Franzensbad, has a spring, besides the one whose analysis is given in the table (Albertsbrunnen), which contains 48 grains of sulphate of soda, 12 of common salt, 7 of bicarbonate of soda, and 25 cubic inches of gas. It is called the Saltzquelle. And there are others containing very little saline ingredients at all. Moor-baths are to be had here.

Franzensbad (1569 feet) is in the neighbourhood of the town of Eger, in Bohemia; and is a town of 2000 inhabitants. It has several cold springs, Salzquelle, Wiesenquelle, Sprudel, and Franzensquelle, of which the first and the last are the most used. They resemble Carlsbad in constitution, containing, however, more gas and sulphate of soda. They also contain minute quantities of iron. It is greatly resorted to by patients suffering from anæmia (bloodlessness), pale girls of this type, and others suffering from poverty of blood resulting from some acute disease or some exhausting illness. The treatment generally adopted here is milder than at Carlsbad, and well suited to excitable and weakly persons. It is a favourite resort of patients suffering from uterine diseases, while it is suited for cases of chronic dyspepsia, catarrh of the bowels, and derangements of the genito-urinary organs. Franzensbad lies on a moor, and the materials for moor, mud, or peat baths are thus at hand in abundance, and the baths themselves are to be had in perfection. Beneath the turf is a layer, many feet in thickness, of a soft black muddy substance. This is diluted with water from one of the springs, steam is passed into it, and it is thoroughly mixed up, and then all hard masses are carefully removed. A bath-tub is filled with this material at a temperature of about 80°, into which the bather steps and remains for about 20 minutes, after which a plunge into clean water removes all black material. Such baths are employed in gout and rheumatism, in some forms of paralysis, in nervous excitement, and over-sensitiveness of the skin. It soothes restlessness, dispels fidgety sensations, and tends to produce sleep. Besides at Franzensbad they are obtained at Carlsbad, Marienbad, Teplitz, Elster, Eilsen, Driburg, Nenndorf, Meinburg, Homburg, Kissingen, and other places.

Friedrichshall is not drunk at the source, but exported only. It is an excellent water for aperient purposes, and in smaller doses for stimulating tissue change in cases similar to those for which Carlsbad is suited. From a quarter to half a tumblerful should be taken in early morning with enough hot water to make it warm, as directed for Carlsbad. In biliary derangements, torpid liver, gout, gravel, specially in the full-blooded individual, it is particularly useful.

Hunyadi Janos is one of the most useful of aperient waters, taken in the morning to the extent of a claret glassful or thereby.

Leamington has several springs besides the one whose constituents are indicated in the table. One of them contains about a grain of iron in 16 ozs., and another is a sulphur spring. Of the aperient spring the defect is the absence of carbonate of soda, which might be remedied by the addition of some other water, such as Vichy. The waters are useful for all the conditions indicated in the paragraphs devoted to the consideration of bitter waters in general, the accommodation is good, and the winter climate comparatively mild.

Marienbad (1980 feet) is twenty-five miles from Carlsbad, an hour's journey from Eger by rail. It lies in a broad valley surrounded by pine-clad hills. The springs resemble those of Carlsbad, but are stronger, are cold, and contain more carbonic acid gas. The chief wells are the Kreuzbrunnen and the Ferdinandsbrunnen. Tichborne's analysis of the former is as follows, in grains per 16 ozs.:—

Sulphate of Soda,	32·0
Bicarbonate of Soda,	11·4
Common Salt,	10·1
Carbonate of Lithia,	·08
Carbonate of Lime,	3·0
Carbonate of Magnesia,	2·0
Carbonate of Iron,	·1

These waters, being stronger than those of Carlsbad, are taken in smaller quantities. They are usually warmed. They are bottled for home use, and may be employed in substitution for Carlsbad and for similar conditions. Two-thirds of a tumblerful and one-third hot water may be taken as a morning dose, which should be sufficient to act on the bowels. A quantity of Marienbad water diluted with almost an equal bulk of hot water makes a draught as nearly resembling Carlsbad water as possible. Marienbad is not used for diabetic patients like its rival. It has 13,000 visitors annually.

Püllna water is a popular bottled water, stronger than Friedrichshall, but with similar action, so that less is necessary, a wine-glassful made warm with hot water being taken before breakfast. Tichborne finds the water to contain evidences of contamination of surface drainage.

Tarasp has already been noted as a health resort on p. 796. It has a cold spring, which is noteworthy for the large amount of antacids it contains. Besides the 38½ grains of bicarbonate of soda noted in the table, it contains 25 grains of bicarbonate of lime and magnesia, and about 3 grains of the indigestible lime sulphate.

Scarborough wells contain too much lime salts (13¾ grs. of sulphate of lime and 6 of carbonate) to be readily absorbed, and lie heavy on the stomach.

Kingswood, in Gloucestershire, is in possession of a bitter spring—the **Cherry Rocks** bitter water; **Beulah** spa, near Norwood, contains in 16 ozs. 61 grains of Epsom and 9 of Glauber's salts, and some common salt; **Streatham** well is another English bitter spring; and there are many others now forgotten.

Kissingen, from its small amount of Epsom salts (see p. 931), might also be ranked as a bitter spa, and **Uriage** also.

IV. Simple Soda Waters (Alkaline Waters).

These are waters whose chief ingredient is bicarbonate of soda. The actions of soda and potash salts have been considered in some detail on pp. 818, 819, 844, and 845. Briefly put soda and potash salts by their direct action (1) are capable of stimulating the flow of the digestive fluid of the stomach, of the bile, and of the pancreatic juice, and thus act as stimulants to digestion and to bile excretion. (2) They directly neutralize acidity of the stomach and bowels. (3) Passing into the blood they increase its alkalinity; and it has been pointed out that a lessening of the alkaline character of the blood is at least invariably associated with rheumatism, gout, and other diseases. (4) They also diminish the acidity of the urine, lessen its irritating character, and avert or diminish the tendency to the formation of certain forms of stone. Besides, in passing through the kidney, soda and potash increase the quantity of urine. (5) Moreover soda is excreted by the lungs, increasing the secretion of the bronchial tubes, and rendering expectoration more copious and free. (6) The directly soothing effect of solutions of soda upon the skin has been referred to on p. 845.

These facts and others of a like kind offer at least some sort of explanation of the circumstances which seem to indicate the use of soda waters to be beneficial. It is quite clear that many kinds of dyspeptic disturbances will be relieved by a course of soda waters, and indigestion is almost certain to be much relieved, and irritable conditions of stomach and bowels, such conditions as are indicated by a tendency to vomiting and diarrhœa. For catarrh of stomach and bowels they are valuable remedies, though when the catarrh is chronic, more stimulating waters, such as the common salt waters, are more likely to be permanently beneficial. The waters are also employed for biliary disorders, enlarged liver, and in cases of gall-stones. In other forms of catarrh, besides that of stomach and bowels, their usefulness is admitted, specially in that of the bronchial tubes, and of kidneys and bladder. In gout and gravel they are widely used, though the more complicated waters of Carlsbad, for example, are in most cases superior. This it would appear is due to the fact that the benefit results not from the mere increased alkalinity of the blood produced, but from the increased stimulus to tissue change and the removal of fat. This soda waters accomplish, but not so satisfactorily as the more stimulating kinds belonging to Carlsbad, Marienbad, &c. Rheumatism is also treated with the alkaline waters, and diabetes is in suitable cases, mild cases in the early stages, frequently benefited. Diseases of women are also treated, but not those attended by poverty of blood, which rather demand iron waters. Indeed it is to be observed that soda waters have a lowering tendency. The prolonged use of even small doses impairs appetite and digestion, and depresses nutrition. The soda waters which also contain appreciable amounts of common salt are more stimulating, and therefore more generally useful. They are mentioned in the next table. It may be observed that the most of the soda waters contain a considerable quantity of carbonic acid gas, and perhaps its slightly stimulating properties may correct some of the depressing tendencies of the soda. In some skin affections alkaline baths are of much use. It will be noticed from the table that Mont Dore, Neuenahr, and Vichy are warm springs, the others are cold. The hot springs are resorted to when it is desired to produce effects after absorption of the waters into the blood, the heat aiding that absorption; the cold springs are chosen when a stimulating effect upon stomach and bowels is specially sought. In the cold springs the quantity of carbonic acid gas is naturally much greater than in the warm waters, and this increases their stimulating properties.

IV. SIMPLE SODA WATERS (ALKALINE WATERS).

Name.	Situation.	Elevation in feet.	Quantity of Soda in 16 ozs.	Quantity of Carbonic Acid Gas.	Remarks.
Apollinaris	A spring near Neuenahr, in Rhenish Prussia	225	9½ grains	47 cubic inches	Cold (62°·6 F.).
Bilin	Bohemia	645	26 ,,	33 ,,	Cold. Season May to September.
Desaignes (Eau de César)	Ardêche (France)		21½ ,,	21 grains	Cold.
Fachingen.......	Nassau, on the Lahn ...	337	28 ,,	33 ,,	Cold. ·11 gr. iron.
Fellathal	Illyria.................		25 ,,	38 ,,	Used for indigestion.
Geilnau..........	Nassau		8 ,,	23 cubic inches	·3 gr. of iron, 6 of magnesia and lime. Cold.
Gerolstein	Rhenish Prussia	1,200	5·7 ,,		4 grs. carbonate of lime and 3 of magnesia
Gettysburg	U.S.A.................		4·6 ,,		15·7 grs. carbonates of magnesia and lime, and 5·3 sulphate of lime
Giesshübel	Bohemia		10 ,,	55 ,,	3½ grs. of lime and magnesia, ·3 of iron. Cold.
Kronenquelle....	See p. 938.				
Mont Dore.......	France (Puy-de-Dôme)	3,300	4 to 5 ,,		Warm springs, 106° to 108° F. Contain also common salt
Neuenahr	Near Bonn, Prussia	276	6 to 10·8 grs.	12 to 47 cub. in.	Hot springs, 93°·2 to 104° F. Common salt 1 to 3½ grs., carbonate of magnesia and lime 3 to 7 grs., ·7 iron.
Preblau	Carniola..............		21 grains	66 cubic inches	Used for indigestion.
Salzbrunn......	Silesia.................	1,270	18 ,,	38 ,,	Bicarbonate of lime and magnesia 7 grs., iron ·002, sulphate of soda 4·7. Whey establishment, moor-baths Cold springs.
Saint Marco	Tuscany	See p. 938.			
Soulzmatt	In the Vosges..........	850	9 grains	9 cubic inches	7 grs. of carbonate of magnesia and lime.
Vals.............	Ardèche (France)	2,475	6½ to 40 grs.	14 to 30 cub. in.	Cold. Traces of arsenic and ·04 to ·2 gr. iron.
Vichy...........	Central France.........	787	24 to 30 grs.	12½ to 14 ,,	Springs 50° to 105° F. Contain also iron and arsenic.

To the same class belong **Chaudes Aigues**, a hot spring (143° to 178°) in Cantal, between Clermont and Toulouse, used for rheumatism and enlarged joints, **Néris**, also a hot spring (114° to 125° F.), in the department of Allier, at an elevation of 800 feet, both feeble alkaline springs, **Evian-les-Bains**, near the Lake of Geneva, a weak spring, and **Teinach**, in Würtemberg, in the Black Forest, 1225 feet above the sea.

Apollinaris is much used as a table water. It is bottled at the spring, which rises in the valley of the Ahr, in Germany, near Neuenahr. Tichborne's analysis shows the constituents in grains per 16 ozs. as follows:—

Bicarbonate of Soda, ...	10·62
Common Salt,..........................	5·
Sulphate of Soda, ...	2·4
,, Potash,....................	·14
Carbonate of Magnesia,.............	4·5
,, Lime,......................	2·88

It is useful in the conditions already indicated, chiefly gout, gravel, bronchial catarrh, tendency to gall-stones; and it is a very pleasant water for ordinary use from the quantity of gas it contains. The quantity of common salt, and Glauber's salt, though too small to classify the water as salt or bitter water, is yet a valuable constituent.

Bilin is in Bohemia, two hours from Teplitz.

Constituents in 16 ounces in grains.

Bicarbonate of Soda,	26·1
Carbonate of Lime,	2·75
,, Magnesia,	1·06
Bicarbonate of Lithia,	·05
Carbonate of Iron,	·1
Sulphate of Soda,	5·13
,, Potash,	1·75
Common Salt,	2·69

This is one of the strongest soda springs in Germany. It is used in similar circumstances to Vichy.

Mont Dore (3300 feet) is three or four hours' driving distance from the railway-station of Clermont-Ferrand, in the department of the Puy-de-Dôme, lying in the Dordogne valley of the Auvergne Mountains. It has six warm springs and one cold. Here there is an excellent bathing establishment, and all varieties of baths are much used in treatment. Inhalations are also given. The place is chiefly resorted to for lung affections, chronic bronchitis, and threatened phthisis, its elevation adding to its suitability for such cases. The season extends from the middle of June to the middle of September, but July is the best month. For cases of rheumatism it is also employed.

Neuenahr is situated in the valley of the Ahr not far from the Rhine, and between Bonn and Coblentz. It has four warm springs, none of them rich in solid ingredients, but all rich in carbonic acid gas, and one cold spring, rich in gas. The scenery in the neighbourhood is picturesque, the town is provided with public gardens and excellent bathing establishments, and the place has become much frequented. The waters are used for gout, rheumatism, scrofula, gravel, and catarrh, alike of digestive organs, bronchial tubes, and bladder. The small quantity of soda, 10·8 grains in the richest spring and only 6 in two of them, renders it questionable whether the benefit is greater than would be achieved by the use of indifferent waters.

Salzbrunn (1270 feet) is situated in Silesia, in a wooded valley, 43 miles distant by railway from Breslau. It has two springs used for bathing and two for drinking. They are cold, and while not very rich in saline ingredients, contain a good supply of gas. It has every advantage in the way of excellent establishments under medical supervision. Its high situation renders it specially serviceable in lung affections. A whey establishment is found, and mud-baths are to be had. The season is from May to October. Since 1880 another water has been introduced from Salzbrunn—Obersalzbrunn—the **Kronenquelle,** or Crown Spring water. The spring rises in the "Prussian Crown" hotel. Its composition is given as follows in grains per 16 ozs.:

Bicarbonate of Soda,	6·1
Bicarbonate of Lithia,	·08
Bicarbonate of Lime,	4·98
Bicarbonate of Magnesia,	2·83
Bicarbonate of Strontia,	·02
Carbonate of Iron,	·06
Common Salt,	·41
Sulphate of Soda,	1·26
Sulphate of Potash,	·28

The quantity of carbonic acid gas is 13½ per cent.

The water is specially recommended in cases of gravel and gout. It is imported in bottles, and may be used as Vichy or Vals.

Saint Marco water has been recently introduced for gravel, gout, rheumatism, and liver and kidney affections. It is sold in bottles, and is derived from a spring on the Marucheto estate in Tuscany. Its chief feature is the considerable quantity of lithia present. Each 16 ozs. contain—

9·116	grains	**Bicarbonate of Soda,**
11·395	,,	Bicarbonate of Magnesia,
1·869	,,	Carbonate of Lithia,
·701	,,	Bicarbonate of Lime,
4·663	,,	Common Salt,
4·567	,,	Sulphate of Soda,
2·155	,,	Sulphate of Potash.

Lozenges are prepared from salts of the spring.

Vals is situated in the Ardèche. The railway-station is Aubenas, from which it is 4 miles distant. It has several springs—Magdeleine, Précieuse, Désirée, Rigolette, and St. Jean. The last is the weakest and the first the strongest, Magdeleine containing 51 grains of bicarbonate of soda in 16 ozs. according to one analysis, and St. Jean only 10·3 according to the same chemist. The former and the spring Rigolette contain also nearly ·2 grain iron, and are used in the weaker classes of cases. At Vals there is also a spring—Dominique—which contains ·005 grain in 16 ozs., and is used in debilitated conditions and in intermittent fevers, and malarial affections of the spleen. Vals waters are, like those of Vichy, bottled under government supervision.

Vichy (787 feet) is situated on the Allier river, in an open valley at the foot of the Auvergne Mountains. It is south of Paris, a distance of about 7 hours' journey by fast train, and on a branch of the Paris and Lyons railway, and the springs, which are nine in number, are the property of the government, and are managed by the Compagnie Fermière de Vichy under the supervision of the government. The waters are drunk on the spot, are used for baths, and are bottled for export; while the Vichy salts, obtained by the evaporation of the waters, are manufactured into lozenges. The mineral establishments are conducted on a magnificent scale, the hotel accommodation is of great variety, and because of these and other circumstances Vichy is the most crowded spa in Europe. The season is from the middle of May to the middle of September, but July is unbearably hot. The daily flow of water from the springs is 113 gallons. In certain parts of the season the quantity required for baths, &c., exceeds this amount. So large vaulted cisterns, 12 feet deep, have been constructed in which the water is stored when less is being used, and from these vaults it is thought a water of more constant composition is obtained. The chief springs are Grande-Grille, Hôpital, Hauterive, Mesdames, Celestins, Parc, Grand-Puits Carré, and Petit-Puits. The last two are chiefly used for baths. The composition of five of these springs is given by Tichborne from a recent analysis as follows, in grains per 16 ozs.:—

	Grande-Grille.	Mesdames.	Hôpital.	Parc.	Hauterive.
Bicarbonate of Soda,	29·48	24·03	31·42	29·8	30·
Bicarbonate of Potash,	2·16	1·12	·42	1·83	1·20
Carbonate of Magnesia,	1·86	2·63	1·23	1·3	3·20
Carbonate of Strontium,	1·9	·02	·02	·04	·02
Carbonate of Lime,	2·66	3·60	3·60	3·82	2·76
Carbonate of Iron,	·03	·20	·02	·02	·1
Sulphate of Soda,	1·81	1·63	1·83	2·01	1·86
Phosphate of Soda,	·8	·03	·3	·93	·3
Arsenic,	·009	·038	·007	·008	·008
Common Salt,	3·28	2·114	3·23	2·857	3·415
Temperature in degrees F.,	105°·8	62°·6	89°	71°·6	59°

The quantity of carbonic acid is from 12 to 13 cubic inches.

The springs of Vichy are the typical alkaline springs, the carbonate of soda being the chief ingredient, the other constituents existing in such small quantity that it is impossible to estimate their exact influence on the action of the waters, though they probably modify the effects on the body. The remarks that have been made on alkaline waters in general fully apply, therefore, to the Vichy waters. The chief complaints because of which recourse is had to Vichy are urinary affections, catarrh of the bladder, stone and gravel; many gouty and rheumatic patients resort to Vichy, the latter class specially for the baths. Catarrh of stomach and bowels, enlargement of the liver and spleen, various disorders of digestion, heart-burn, painful digestion, gall-stones, and biliary colic are also suitably treated by a course of Vichy waters. Vichy water is the chief mineral water for use in diabetes, and in the milder forms of the disease is said to produce marked improvement. Vichy and Carlsbad are the two chief waters for this purpose. The Vichy waters and baths are also much used in uterine affections. Corpulence is also effectively treated by these waters. It is to be noted that the Mesdames spring contains more iron than any of the others, and it is, accordingly, employed for the weaker class of patients. Hauterive, and a spring resembling it, Celestins, is said to be less suited than Grande-Grille and Hôpital for irritable and nervous patients.

The bottled waters are taken before meals, from $\frac{1}{2}$ to 2 pints being consumed daily, and they are used to stimulate digestion and remove acidity. The lozenges, "pastilles digestives," are similarly used, four, five, or six being taken before meals, while the dry Vichy salts are used for baths. Each packet contains $\frac{1}{2}$ lb., the quantity needful for one bath.

The season at the springs begins on the 15th May and closes at the end of September; but the thermal establishment is open all the year, and October and November, and from February onwards, are not unfavourable times.

Besides the springs named, there are others, notably the spring Larbaud, and the spring Lardy, both provided with thermal establishments. The waters of both of these springs contain also a small proportion of iron, in the form of carbonate; the former containing ·2 grain in 16 ozs. and the latter ·16.

V. Soda Waters with Common Salt (Muriated Soda Waters).

It is not necessary to make any very detailed remarks upon this class of waters. The carbonate of soda is still the chief ingredient, and the common salt is believed to add to its effect and correct any tendency to bad results. It has been pointed out that soda tends to have a depressing effect on nutrition by hastening the destructive change of substance. This is believed to be partly, at least, the means by which fat is lessened and emaciation produced. The presence of any quantity of common salt, in addition, promotes the constructive portion of the tissue change. Thus Braun says, "Chloride of sodium (common salt) is an important corrective as regards both the local and the general effect of the carbonate of soda, . . . and, for most of the conditions requiring soda waters, a considerable amount of common salt in them is all the more to be recommended, the greater the amount of carbonate of soda which they contain. To this may be traced, in great part, the pre-eminence which, after years of experience, has been obtained by the waters of Ems and Selters, and even by Roisdorf, above pure soda waters, and the rapid prosperity of Gleichenberg, and especially of Luhatschowitz. It would be well worth the trouble in cases in which the strong soda waters of Vichy, Vals, Bilin, and Fachingen have failed in their effect, or have manifested bad incidental results, to render them muriatic alkaline waters by the corresponding addition of chloride of sodium." Whenever in addition to the correction of acidity of the stomach and bowels, &c., a stimulating effect upon digestion and tissue change is desired these soda waters with salt are to be preferred.

V. SODA WATERS WITH CARBONIC ACID GAS, AND CONTAINING ALSO COMMON SALT.

(Muriated Alkaline Waters, Muriatic Soda Waters.)

Name.	Situation.	Elevation above Sea in feet.	Amount of chief Constituents in 16 ozs.			Remarks.
			Soda in grains.	Common Salt in grains.	CO_2* in cubic in.	
Ems	Nassau	291	15	7	19	Warm springs.
Birresborn	Rhenish Prussia	1,100	20	7	17 grs.	Contains 9½ grs. bicarbonate magnesia and lime.
Gleichenberg	Styria	872	27	14	35	Cold. Carbonate of lime and magnesia, of each 4 grs. Several springs, one—the Klansner—contains ·66 gr. iron.
Kainzenbad	Upper Bavaria	2,400	4	—	—	Moor-baths. Excellent climate, good bath arrangements, climatic health resort. Sulphur and iron springs here also.
La Bourboule (Choussy).	Auvergne (France).	2,600	10	22	abundant	Warm springs. Contains also arsenious acid, ·08 gr. (See p. 951.)
Luhatschowitz	Moravia	1,600	33 to 61	23 to 33	14 to 50	Four different springs. Cold. Contains bromide of sodium ·255 gr., iodide of sodium ·132, and carbonate of iron ·111. Whey establishment.
Roisdorf †	Rhenish Prussia	1,000	9	3 to 14	19	Contains iron ·2 gr.
Royat	Puy-de-Dôme (Fr.).	1,380	5 to 9½	10 to 12	—	Warm springs, 66° to 96° F.
Selters	Nassau	800	10	17	30	
Vic-sur-Cère	Cantal	—	15	11	—	7 to 8 of sulphate of soda. Minute quantities of iron and arsenic. Used in liver and kidney affections.

* CO_2 = Carbonic acid gas. † Exported only.

Other waters belonging to the same class are **Tönnisstein**, near Brohl on the Rhine, which has a cold spring, the water of which is exported, and **Szezawnica**, in Galicia, 1050 feet above sea-level, whose waters are cold, and richer in soda and salt and carbonic acid gas than Ems or Gleichenberg.

Ems is situated on the Lahn, in a narrow valley of Nassau, surrounded by wooded and vine-clad rocky heights. It is a few miles east of Coblentz and about 25 north of Schwalbach. The spring is at a little distance from the town, which now numbers nearly 7000 inhabitants, increased by 8000 visitors during the season. The climate is mild but moist, and in summer relaxing, specially so in July and August, so that May and June, September and October, are the best months. It is unsuitable for consumptives. Ems is easily reached from England, is provided with excellent hotels, and is quite a desirable place for

English needing its treatment. "There are few bathing resorts," says Braun, "where a sick person may find in intercourse with nature and man, and in the enjoyment of a brilliant and yet somewhat unpretending spa-life, such rich opportunity both for coming out of himself and for self-reflection; in both respects Ems is the pearl of Germany." The two chief springs are Krähnchen and Kesselbrunnen. The following table from Fresenius shows their composition in grains per 16 ozs.:—

	Krähnchen.	Kesselbrunnen.
Bicarbonate of Soda,	14·8	15·19
Bicarbonate of Magnesia,	1·505	1·436
Bicarbonate of Lime,	1·724	1·812
Bicarbonate of Iron,	·016	·027
Common Salt,	7·084	7·77
Sulphate of Soda,	·137	·006
Sulphate of Potash,	·328	·393
Carbonic Acid Gas,	83 cub. in.	67 cub. in.
Temperature,	84°·2 F.	114°·8 F.

Ems waters are specially employed for chronic catarrh of the air-passages, specially in gouty persons, as well as for disorders of digestion, sluggish liver, &c. A spring—Bubenquelle—used for bathing purposes, and particularly in the form of an ascending douche, used to be famous for disorders of the womb and sterility consequent upon them.

Gleichenberg (872 feet) "is situated in a pleasant hilly country," 7 miles from Gratz in Styria. Its waters are somewhat richer in carbonate of soda and in common salt than those of Ems, and "in a climatic point of view it deserves the preference." Its climate is mild, and the district is attractive.

Luhatschowitz, 2½ miles from the Hradisch station on the North-Austrian Railway, has springs rich in alkaline constituents, which serve all the purposes for which soda springs with salt are suitable. The climate is mild but moist, as it lies in a valley, though 1600 feet above sea-level.

Royat (1380 feet) is a little over a mile from Clermont-Ferrand, in a beautiful valley of the Auvergne Mountains. There are four springs, Eugénie, St. Mart, Cæsar, and St. Victor, of which the constituents in grains per 16 ozs. are as follows:—

	Eugénie.	St. Mart.
Bicarbonate of Soda,	9·443	5·12
Bicarbonate of Potash,	3·045	1·09
Carbonate of Lime,	7·000	3·71
Carbonate of Magnesia,	4·7	2·37
Carbonate of Iron,	·28	·14
Sulphate of Soda,	1·295	1·05
Phosphate of Soda,	·126	trace
Common Salt,	12·096	9·98
Chloride of Lithia,	·245	·22

Traces of arseniate, iodide, and bromide of soda.

The Victor spring is stronger than St. Mart, and in particular in iron, containing ·39 grain. The waters are largely used for gout and rheumatism, catarrhal affections of stomach and bowels, kidneys and bladder; and the St. Victor spring is specially fitted for delicate persons, sufferers from debility, bloodlessness, and for delicate women suffering from complaints connected with the generative organs. Royat is a good substitute for Ems, and its climate is preferable, especially in July and August. There is a thermal establishment fitted up with all modern bathing appliances.

Selters water is used only in the bottled form, and is not drunk at the springs. The town of Selters is a short distance from Schwalbach (p. 950). Tichborne's analysis—the most recent—is as follows (grains per 16 ozs.):—

Bicarbonate of Soda,	4·7
Carbonate of Lime,	2·2
Carbonate of Magnesia,	2·15
Chloride of Magnesia,	1·50
Carbonate of Iron,	·15
Common Salt,	16·24
Chloride of Potash,	·24
Sulphate of Soda,	·21
Phosphate of Soda,	·31
Carbonic Acid,	30 cub. in.

VI. Sulphur Waters.

Sulphur waters are those which contain sulphuretted hydrogen gas in solution. This gas is a compound of sulphur and hydrogen, and its chemical symbol is H_2S. It is a gas of a very fœtid smell, familiar enough to everyone as produced in the decomposition of albuminous materials. It is the development of this gas which causes the particularly offensive smell of rotten eggs. Sulphur waters either contain this gas in solution, or they contain substances which by chemical changes yield the gas. Such substances are chiefly sulphides, sulphides of soda, lime, potash, and magnesia, and to some extent also sulphates.

Sulphur waters are used both for bathing and for drinking purposes. Whatever may be the effects of sulphur waters when taken internally for any time, it is now generally believed that baths of sulphur water cannot produce any effect, which cannot equally well be produced by ordinary warm baths. It is pointed out that the quantity of sulphuretted hydrogen in most of the waters is so small that it can hardly have any specially stimulating effect upon the skin, and that in the ordinary bath no chemical change occurs to produce more of the gas, a change which, however, may occur in the stomach when the water is drunk. It is also pointed out that no indications of sulphuretted hydrogen having passed into the blood through the skin are ever produced. Braun, therefore, concludes that the sulphur baths are probably nothing better than ordinary water baths. It is also to be remembered that the most famous sulphur baths are those of the Pyrénées, where all the advantages of mountain air and elevated situation combine with the courses of baths and waters.

It is, however, admitted that valuable effects are produced when sulphur waters are taken internally, and it is to the sulphuretted hydrogen actually present in the water when it is drunk, or produced from sulphides after drinking, that much of the beneficial effect is due. The sulphuretted hydrogen passes from the stomach into the blood, proceeding to the liver, and combines with blood corpuscles in course of breaking down, leading to their speedier removal from the body. During a course of such waters the motions become dark and finally black in colour, due it is said to the expulsion of this waste from the liver. Evidence of such a quickening of destructive change in the blood is found in the production of some amount of poverty of blood, requiring the use of a generous meat diet, and sometimes a course of iron waters subsequent to the sulphur.

On this account sulphur waters are employed in cases of torpid and enlarged liver, in cases of piles, in cases of catarrh of the air-passages, associated with such conditions of the liver and bowels, in early cases of consumption, and in various other affections of the lungs. How far the benefit experienced by sufferers from such lung affections is due to the sulphur water and how far to the mountain air of the resort is an interesting question. Various skin diseases, old ulcers, gunshot wounds, gout, rheumatism, and syphilis are also treated by the baths; and cases of chronic metallic poisoning, especially lead poisoning, are benefited by courses of the waters. The liver is the chief organ where metallic poisons are deposited, and it may be that the action of the sulphur on the blood flowing to the liver facilitates the removal of the deposits. The drinking of sulphur water is attended rather by constipation than by relaxation of the bowels, and they do not improve the appetite as do most other mineral waters, though they do not impair it.

At many of the sulphur water resorts the remedy is employed not only in baths and courses of the drinking waters, but by inhalation of the gas escaping from the water. This is thought to be serviceable in affections of the air-passages and in consumptive disease of the lungs. The air inhaled contains of course only a very small percentage of the sulphuretted hydrogen, for the inhalation of any quantity of the gas produces symptoms of poisoning, giddiness, faintness, headache, trembling, and in fatal quantity convulsions and delirium. Even a small percentage of the gas in the air will produce feelings of general discomfort and headache.

It has been already pointed out (p. 827) that some of these waters are employed to yield up their sulphuretted hydrogen for injection into the bowel as a treatment for consumption.

The table on the following page contains the names and chief facts concerning most of the sulphur waters in use; and only of a few of these will any further remarks be made.

Aix-les-Bains, in French Savoy, is one of the most fashionable and frequented of spas, chiefly on account of the baths, for which the arrangements are on a most complete scale, every variety of bath being provided, and inhalation chambers also. The town is in a beautiful neighbourhood, at an elevation of 850 feet, and very near some of the pleasantest scenery in the Alps. Living is moderate, there is agreeable society, and it will be found on the whole one of the most pleasant of resorts. It is a station on the railway from Paris to Mont Cenis, an eleven hours' journey from Paris, and a three hours' journey from Geneva. The springs are hot; the waters are abundant, yielding a million gallons a day; and they are chiefly used for baths in rheumatism, gout, sciatica, and nervous affections. Though the waters are used for drinking, they are too weak to yield the full effects of sulphur waters, but near to Aix are the sulphur springs of **Marliox**, which are cold and can be used for drinking in combination with the hot baths of Aix. Near to Chambéry, nine miles from Aix, is the spring of **Challes**, a strong sulphur water, containing also iodides and bromides, which is brought to Aix-les-Bains to compensate for its weak waters. The season begins early in May and lasts till October, though during the latter part of July and the early part of August the heat is rather great for comfort.

Aix-la-Chapelle or Aachen, the *Aquis Granum* of the Romans, between Brussels and Cologne, is the chief sulphur bathing resort of Germany. It is a town of over 85,000 inhabitants. The baths are exceedingly complete, though the surroundings are not nearly so engaging as those of Aix-les-Bains. The considerable quantity of

VI. SULPHUR WATERS.

Name.	Situation.	Altitude in feet.	Temperature of Spring in degrees Fahr.	Cubic Inches of Sulphuretted Hydrogen in 16 ozs.	Chief Constituents in grs. per 16 ozs.					Remarks.[1]
					Common Salt.	Carbonate of Soda.	Sulphates.	Carbonates of Magnesia and Lime.	Sulphides.	
Abano	near Padua									
Aix-les-Bains	Savoy	850	107° to 113°	0	·1	·1	1·7		0	·07 iron.
Aix-la-Chapelle (Kaiserquelle)	Rhenish Prussia	534	129°	0·6	20	5	3 2	1·6	·07	Iron ·07.
Allevard-les-Bains	Isère (France)	1,473	61°	Rich in this gas and in carbonic acid gas.	3½		9	2		
Amélie-les-Bains	East Pyrénées	680	108°	trace	⅒		·8		·24	
Ax	Ariège (Fr.)	2,300	60° to 90°	Has no less than 53 springs.					·002	
Baden (Römerquelle)	Austria	638	95°	·08 to ·6	2	½	4		·36	
Baden	Switzerland	1,180	117° to 122°	small	13		13	2½	13	Mild in winter.
Bagnères de Luchon	Central Pyrénées	2,000	63° to 132°	trace	½		·9		·4	Mild climate and excellent accommodation.
Barèges	Hautes-Pyrénées	4,200	87° to 113°	tracc	⅓		4		·36	
Battaglia	near Padua									
Buffalo Lithia Springs	Virginia, U.S.	(see p. 946).								
Builth	Wales	Weak sulphur well.								
Burtscheid	near Aix-la-Chapelle		136°	·12	21	5	9	1·3	4·8	
Cauterets	Hautes-Pyrénées	3,250	102·2°	traces	⅓		·3		·14	
Challes	Savoy (see p. 942).									
Eaux Bonnes	Basses-Pyrénées	2,434		·14	2		1½			
Eaux Chaudes	Basses-Pyrénées	2,215	79°	trace	1		10		·05	
Eilsen	North Germany	250	54·5°	1·5			9¾	1½	9¾	·4 iron, 1½ cub. in. CO_2.
Enghien	Seine-et-Oise, near Paris	52	50° to 57°	abundant						
Grosswardein			110°	5·3 (?)		6	9	4½		3 cub. in. CO_2.
Gurnigel	near Thun	3,787								
Harkany			136°	4	2·3			9		
Harrogate (old sulphur well)	England	600	cold	·66	86			1·2	1½	2½ cub. in. CO_2.
Helouan	4 miles S. of Cairo		90°	trace	·05	Good bathing arrangements.				
Heustrich	Berne	2,000				6				
Kainzenbad (Gutiquelle)	Bavaria	2,400		3·9		4	¾			
Spring at Kreuth	Bavaria	2,911	52°	·2			19½	9·7		·25 iron.
Langenbrücken	Baden	440	52°	·13 to 3			1	2·3		20 cub. in. CO_2.
Le Vernet	East Pyrénées	2,000	Hot sulphur springs used for baths. Visited in winter by persons with delicate chest, because of mild climate.							
Lisdunvarna	20 miles from Ennis (Ireland)			·5						
Llandrindod	Wales									
Llanwrtyd	South Wales			·5	6·4					
Mehadia	Hungary		70·7° to 130°	½ to 1	7 to 31		⅓	½		
Meinberg	Principality of Lippe-Detmold	634		½			16	2	·06	
Moffat	Scotland	400	Cold	·137	6·9			·46		Chloride of lime and magnesia 14.
Nenndorf	Westphalia		63·5°	·4 to 1·18			9 to 15	3 to 4		4 to 8 cu. in. CO_2.
Panticosa	Spain	5,000	77° to 91·4°	Rich in H_2S and nitrogen. Used for chest affections.						
Pystjan (Posteny)	Upper Hungary		111°	·47			6½			
Saint Sauveur	Hautes-Pyrénées	2,360	93·5°							
Schinznach	Switzerland, 2 hours from Baden	1,080	95°	1·7		1	10	1		2½ cub. in. CO_2.
Stachelberg	Switzerland	2,178	Cold.							
Strathpeffer (upper well)	Ross-shire, Scotland			3½ per 20 oz.			7½			16 grs. lime salts.
Töplitz Warasdin	Croatia	900	136°	6½	1		3½	3½		3 cub. in. CO_2.
Uriage	Isère (Fr.), near Grenoble	1,300	80°		59		37 of soda and magnesia	15		
Weilbach	Nassau, Prussia	420	57°	·16	2	3	·3	5½		3 cub. in. CO_2.
White Sulphur Springs	West Virginia, U.S.	2,000	62°	·02			6½	½		1 cub. in. CO_2.

Abano and Battaglia, on the line from Padua to Bologna, are hot springs from the Enganean range, stronger in salt than but otherwise similar to Aix-la-Chapelle.

Lavey, in the Rhone valley, near the station St. Maurice, 1420 feet high, has hot sulphur springs with common salt and sulphate of soda.

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[1] CO_2 means carbonic acid gas.

common salt in the water is noted in the table, and doubtless much of the efficacy of the water is due to it. The waters are used for drinking as well as for baths. Drawn from the spring it is very hot, and visitors sip it as they promenade up and down. They usually begin with 6 or 8 ounces, and gradually increase to a pint or a pint and a half. The baths are usually prolonged from a half to three-quarters of an hour. Rheumatism, gout, nervous cases, syphilis, stiff joints, skin diseases, diseases of liver and abdominal derangements generally, and cases of metallic poisoning are treated here. The season is from June to the end of September, but the baths are open all winter. The water is exported also. **Burtscheid** is situated so near Aix-la-Chapelle that it may be called a suburb, but its springs though hotter are less strong in sulphur.

Amélie-les-Bains (680 feet), in the Pyrénées, 24 miles south of Perpignan, is provided with all sorts of bathing arrangements, which are specially employed in rheumatic cases, and with arrangements for inhalation, used in cases of consumption, for which its mild climate is specially suited. It is also suitable for a winter residence.

Allevard-les-Bains (1473 feet), in south-eastern France, has of late come into repute for the treatment of chest affections, bronchitis, asthma, &c., and also for skin affections and rheumatism. It is two hours' journey from Grenoble, and six from Lyons or Geneva. The nearest station is Goncelin.

Barèges (4200 feet), 12 miles from the railway-station of Pierrefitte, is one of the highest and most famous springs of the Pyrénées. It is resorted to for paralysis, rheumatism, old wounds, skin diseases, and bone diseases. The accommodation, however, is poor, and the surroundings dismal. A peculiar organic matter of a gelatinous nature found on the surface of the water is called **baregine**, from the name of the town. The season is July and August.

Bagnères de Luchon (2000 feet), in the valley of Luchon, 5 hours' journey by rail from Toulouse, is surrounded by the splendid scenery of the Pyrénées. Although this water contains very little sulphuretted hydrogen, yet as soon as it is drawn into the bath it becomes milky, as if from the deposit of sulphur, and the gas is developed and escapes into the air, which immediately above the bath contains as much as 1 per cent of the gas. It has been supposed that silica contained in the water takes part in this change.

Cauterets (3250 feet), in the Hautes-Pyrénées, 6 miles from Pierrefitte railway-station, is much frequented by persons suffering from chest affections. Chronic rheumatism and skin diseases, uterine affections and early stages of consumption are also treated. The situation is high, and much of the benefit may be due thereto, though horses "from the studs of Tarbes and Pau, which are afflicted with chronic bronchial and stomach catarrh, diarrhœa, emaciation and spermatorrhœa, are sent to the springs at Cauterets, and are often cured there in a week" (Braun). The climate is variable; and the best months are July, August, and September.

Eaux Bonnes is situated in the Pyrénées at an elevation of 2434 feet, in a narrow sheltered ravine, at the foot of the Pic du Gers, and is reached from Pau, from which it is distant 20 miles. The climate is subject to sudden changes of temperature, but the situation and scenery are very attractive. It is said to produce excellent results in clergyman's sore throat and lung affections, specially of the tubercular kind, which may be due to the elevated situation. The water is taken in very small quantity to begin with, a table-spoonful or so, and is cautiously increased to 4 or 5 glasses daily.

Eaux Chaudes (2215 feet), also in the Pyrénées, is reached by diligence from Pau, and is situated in a narrow and picturesque but gloomy gorge, and subject to rather sudden changes of temperature. The waters are chiefly used for baths in cases of chronic rheumatism, muscular rheumatism, and chlorosis and neuralgias. It is 4 miles distant from Eaux Bonnes. The season is from 1st June to 1st October.

Harrogate is in Yorkshire, 30 miles west of York, partly situated on high ground (600 feet) and partly in the valley. The air is pure and bracing but moist, and the soil is sandy and readily dries after rain. It contains not only sulphur wells which are among the strongest known, but also iron springs. There are considerable social attractions, and during the season, June to October, the climate is pleasant. The waters are taken between 7 and 8 a.m., and the dose is from one to three tumblerfuls, a short walk being taken between each glass, the third being followed by a longer walk back for breakfast. The waters open the bowels, acting upon the liver also, and removing constipation. They are thus useful also for sluggish liver, abdominal congestion and piles, especially when resulting from rich living. They also promote change of tissue and are used as a remedy for corpulence and for the removal of thickenings of glands and gouty and rheumatic swellings. They are useful for full-blooded persons with a tendency to apoplexy, also in cases of enlargement of the womb; and it is a favourite resort for overworked business men. A course of eight days to three weeks is usually taken in the quantities already named, when the opening action is chiefly sought, and when the waters are taken to promote tissue change from 2 to 8 ounces is the quantity taken cold three or four times a day. If the waters lie heavy on the stomach they are taken warm. Chronic rheumatism, gout, and syphilis are also treated. Cases of threatened consumption, and disorders of the monthly illness in young persons are treated with the sulphur baths, and the iron waters internally. Much of the effect of the sulphur waters is believed to be due to the large quantity of common salt contained in the waters.

Moffat in Dumfriesshire, Scotland, is an excellent health resort in summer and up to the middle of September. Its climate is good, and much picturesque scenery is within easy driving distance. The well is fully a mile from the town; the waters are very mild but generally suitable for cases similar to those described for Harrogate. A hydropathic establishment is within a mile of the railway-station.

Saint Sauveur (2360 feet) is a fashionable "ladies' bath," being much used by women for nervous complaints and affections of the generative organs. It is approached from Lourdes, is 4 miles from Barèges and is close to some of the finest scenery of the Pyrénées. The season commences in May and ends in October.

Strathpeffer, amid wild and picturesque scenery at the foot of Ben Wyvis in Ross-shire, Scotland, is becoming more frequented since the building of a suitable establishment near the wells. There are two springs, the upper being the strongest sulphur spring in Britain. The water acts strongly on the kidneys, but is constipating owing to the large quantity of lime salts. Three tumblers are usually taken before breakfast and as many more in the afternoon. Chronic cases of sciatica, lumbago, and rheumatism find relief; and the water has a strong effect on the skin, shown by the cuticle coming off in scurf.

Lisdunvarna, in Ireland, about 20 miles from Ennis, possesses a sulphur spring, containing ½ a cubic inch of sulphuretted hydrogen in 16 ozs., and several iron springs, but the place has no suitable arrangements for visitors.

VII. Earthy Mineral Waters (Lime Waters).

The earthy mineral waters are those in which lime is a prominent constituent. It occurs in the form of carbonate and sulphate. Of the two, the carbonate is the salt to be desired, and the sulphate of lime in any quantity equal to 10 grains or upwards is undesirable, because it lies heavily upon the stomach and lessens the absorption of the water into the blood. Carbonate of magnesia is another salt which occurs specially in earthy mineral waters, and is more readily absorbed than the lime salts.

It was believed at one time that these waters had a special value in diseases of bone, in rickets, in the disease called osteomalachia, because they supplied lime to the system, a deficiency of which was supposed to be at the root of the disorder. It is quite clear, however, that abundance of lime salts is supplied in the food eaten and in water, and that the disease is not due to deficiency of the phosphate of lime, but to some digestive derangement or to some disorder of the tissues which prevents the lime salts obtained from the food being made proper use of in the body. Consequently such bone diseases are treated by appropriate food, tonic treatment of various kinds, and change of air. Lime waters have, however, other uses. They correct acidity of the stomach and bowels, and they appear to be useful in gravel and in kidney and bladder affections. They are somewhat constipating, and, therefore, useful in diarrhœa and irritable conditions of the bowels. They have a reputation in scrofula, gland diseases, and tubercular disease, but there is no satisfactory reason for such repute. Earthy waters are used as baths, but the lime salts they contain are of no effect, and do not modify the action of the simple water.

Many of the waters already named contain considerable proportions of lime salts; thus of the waters named in the last table the water of Baden in Austria contains 5 grains of sulphate in 16 ounces, Baden in Switzerland 10 grains, Eilsen 17 grains, Grosswardein 2 to 3 grains, Nenndorf 5 to 8 grains, Schinznach 6 grains, Pystjan 4 grains, Töplitz 1 to 3 grains, while carbonate of lime is contained in Eilsen water, that of Aix-la-Chapelle, Baden near Vienna, Baden in Switzerland, Grosswardein, Nenndorf, Harkany, and Weilbach. In Table II., Baden-Baden, Canstatt, Cronthal, Dürkheim, Homburg, Mergentheim, Mondorf, Nauheim, Pyrmont, Schmalkalden, and Wildegg have been mentioned as containing various quantities of these lime salts. In Table III. the presence of sulphate of lime in several of the bitter waters is noted in some quantity, and in Tables IV. and V. the presence of carbonate of lime in the soda waters. In all these waters the lime salts have been unimportant constituents in comparison with the other ingredients, worthy of note only when present in such quantity as to make the water difficult of digestion. In the present waters, however, the absence of other ingredients in quantity makes the lime salts the chief feature of the water. For this reason it must be understood the table does not include all waters containing lime salts in any proportion, in which case it would be of great length, but only those in which they rank as the chief ingredients from the absence of others.

VII. EARTHY MINERAL WATERS (WATERS CONTAINING LIME).

Name.	Situation.	Altitude in feet.	Chief Constituents in grains per 16 ozs.					CO_2* in Cubic Inches.	Remarks.
			Lime as Carbonate.	Lime as Sulphate.	Other Carbonates, Soda, Magnesia, &c.	Other Sulphates, Potash, Soda.	Common Salt.		
Alet	Aude (France)	650	1·89	·2	·8	—	·3		Used in stomach and bowel affections.
Bethesda	Wisconsin, U.S.A.	—	2·04	—	1·6	·1	·139		Prescribed in kidney and bladder diseases and in diabetes.
Buffalo Lithia	Virginia, U.S.A.	500	1½ to 4	2 to 3	·15 to 3	1	⅒ to ½	1 to 6	½ cubic in. sulphuretted hydrogen.
Chateldon	Puy-de-Dôme, France		3·61	·35	4½	—	·2	15 grains	·245 iron.
Condillac	Vaucluse (Fr.)	Imported as a table water.							
Contrexéville	Vosges (Fr.)	1,000	2¾	8	⅕	1¾	—	½ grain	
Couzan	France								
Cransac	near Aubin in Auvergne	Besides sulphates of lime and magnesia contains 13 grains sulphate of alumina in 16 ozs. Used in enlargements of liver and spleen, and intermittent fever.							
Inselbad	Westphalia		2	0	—	0	6	trace	·02 iron, 2·78 cub. in. of nitrogen; used for inhalation in cases of consumption.
Johannisbrunnen	From spring near Niederselters in Nassau.		3½		2¾	½	15	abundant	A sparkling table water.
Leukerbad (Lorenzspring)	Switzerland	4,670	0	10½	—	nearly 3	(see p. 927).		Warm, contains ·079 iron.
Lippspringe	Westphalia	441	5	2	—	7¾	nearly 2	5	·1 iron.
Lucca	See Table I.								
Poland Spring	Maine, U.S.A.	800	·135	Practically an indifferent water. Used specially in kidney disease and diabetes. Excellent accommodation.					
Pougues	Loire (France)	780	9·28	1·33	11·2	1·89	2·45 chloride of magnesia	little	·14 iron.
St. Galmier (Source Nouvelle)	Loire (Fr.)	1,350	with magnesia 3·4	with soda 1·2	3	·55	1·5	abundant	·06 iron, an excellent table water.
Sulis	See Bath, p 925								
Taunus	Table water from spring near Frankfort-on-the-Main	390	9½	½	1·3	—	18	20 grains	
Weissenburg	near Thun	2,758	0	17		5		¾	
Wildungen	Waldeck	740	5 to 9	0	5 to 16	⅓ to ½	8	33	

* Carbonic acid gas.

Bethesda and Buffalo Lithia Springs are both in the United States of America. The former is at Waukesha, in Wisconsin, and the latter in Virginia. I have no authoritative statement as to their physiological action and curative effects. Bethesda water is, however, lauded in Bright's disease of the kidney and in various kidney and bladder affections, and very specially in diabetes. The Buffalo water is deemed valuable on account of the carbonate of lithia it contains to the extent of from ·148 to ·225 of a grain in 16 ounces. It is recommended in gout, rheumatism, gravel, disease of the kidney, specially chronic Bright's disease, and bladder, and in stomach and bowel disorders. It is said to contain sulphuretted hydrogen. Both are to be had in bottles.

Contrexéville (1000 feet) is situated in a narrow valley of the Vosges Mountains, over a thousand feet above sea-level. It is subject to sudden changes of temperature both morning and evening, a fact visitors should remember. It has a special reputation in the treatment of gravel and stone, as well as diseases of the kidney, catarrhal affections of the bladder and prostate gland, in gout and liver disorders, in incontinence of urine in children, and in diabetes. Patients begin with two or three glasses in the morning before breakfast and gradually increase the quantity to 12, 15, or upwards. There is a well-equipped bathing establishment, and abundance of hotels. There are several springs, the Pavilion being the chief. Its waters contain a small quantity of iron, ·05 grain in 16 ounces, and a trace of arsenic. The water is largely exported. From half to one bottle is taken daily with food as a table water, or in milk or wine or spirit. The season is from 20th May to 15th September.

Lippspringe and Inselbad, near Paderborn in Westphalia, are specially resorted to in consumption and other affections of the chest. One to three glasses of the water are drunk in the morning and one or two in the afternoon. Baths are also employed. The repute of the place is to some extent due to the nitrogen gas contained in the waters, which is given off in chambers in which patients inhale it.

Pougues (780 feet) at one time enjoyed great popularity for dyspepsia and bladder irritability and catarrh. It lies in the valley of the Loire, not far from Nevers, in a pleasant country, and much has lately been done to restore its celebrity. Its waters are imported.

Weissenburg lies in a narrow gorge off the Simmenthal in Switzerland, 3 miles from Thun, surrounded by mountains and pine-trees. "The air is calm, mild, and moist, but the weather variable." It has a great reputation in cases of chronic bronchial catarrh and consumption, believed to be due rather to its elevation (2758 feet), its sheltered situation, calm air, and atmosphere of pine-wood, than to its spring.

Wildungen lies in a valley of Waldeck, 300 feet above sea-level. It is three hours' journey from the Wabern station on the Main and Weser railway. Its two chief earthy springs are the Georg-Victor-quelle, and the Helenenquelle, and it has besides an iron spring. The Georg-Victor has 5·4 and the Helenen 9·7 grains of carbonate of lime. There is no lime sulphate, but the sulphates of soda and potash are ·6 and ·3 respectively. The Helenen-quelle contains 8 grains of common salt in 16 ounces and 6 of bicarbonate of soda, 10·4 of bicarbonate of magnesia, ·143 carbonate of iron, and 34 cubic inches of carbonic acid gas, while the quantities in Georg-Victor are ·06, ·49, 4·1, ·161 grain, and 33 cubic inches of gas. The third spring, Thalquelle, contains 6·67 common salt, 10 bicarbonate of lime, 9·8 bicarbonate of magnesia, ·1 carbonate of iron, and 33 cubic inches of gas. The water, specially the Georg-Victor spring, is much used in chronic catarrh of the bladder, incontinence of urine, in gravel, and other affections of the kidney.

VIII. Iron Waters (Chalybeate Springs).

Iron or steel waters are not the only mineral waters in which some form of iron is found. Indeed in nearly all mineral waters this ingredient exists, but in very many in such small quantity, while other ingredients are so conspicuous, that the character of the water can hardly be supposed to be affected by that metal. There is no stated amount of iron which entitles a spring to be classed as chalybeate, though those most successfully resorted to contain from $\frac{1}{3}$d to $\frac{9}{10}$ths of a grain of iron in the form of carbonate in 16 ounces. Some springs are classed as iron springs which contain barely $\frac{1}{5}$th of a grain in 16 ounces of water, but they are so because they have been found by the actual experience of cases to have the beneficial effects of steel waters. Indeed it is rather the experience of the value of the water in particular forms of disease than the actual quantity of iron it contains that determines how it should be ranked. What are called **pure iron springs** are those which contain but a few grains of dissolved solids, a salt of iron existing to some appreciable amount; **compound iron springs** contain moderate quantities of other salts, such as Epsom and Glauber's salts, common salt, sulphate of lime, besides being rich in carbonic acid gas. To this class some of the springs already named are entitled to belong, such as Franzensbad, Marienbad, Tarasp, Elster. We take the following list of springs containing iron from Braun, springs which we have already considered, and we note the amount of iron in the form of carbonate which each contains in grains per 16 ounces:—

Common Salt Waters (Table II. p. 929).

	Grains of Iron in 16 ozs.
Cronthal,	·04 to ·05
Ischl,	
Mergentheim,	
Wiesbaden,	
Adelheidsquelle,	·07
Baden-Baden,	·05 to ·25
Canstatt,	
Mondorf,	
Nauheim,	
Schmalkalden,	
Soden,	
Hall,	·08

	Grains of Iron in 16 ozs.
Dürkheim,	·12
Kissingen,	·2 to ·24
Harrogate (Montpellier Spring),	·27
,, (Kissingen Spring),	·37
Kreuznach,	·35
Rehme,	·5

Bitter or Aperient Waters (Table III. p. 934).

	Grains of Iron in 16 ozs.
Carlsbad,	·01 to ·02
Franzensbad,	·01 to ·37
Rohitsch,	·06
Füred,	·08
Tarasp,	·19 to ·2
Marienbad,	·27 to ·47
Elster,	·35 to ·48

Soda Waters (Tables IV. V. pp. 937, 940).

	Grains of Iron in 16 ozs.
Giesshübel,	·004
Ems,	·01 to ·05
Salzbrunn,	·04 to ·07
Preblau,	·05
Roisdorf,	·05 to ·2
Apollinaris,	·06
Selters,	·07
Bilin and Fachingen,	·08
Luhatschowitz,	·09 to ·18
Gleichenberg,	·14 to ·18
Geilnau,	·16

The reason for the use of iron waters is that iron is a necessary ingredient of the blood (see pp. 216 and 816), and in certain conditions promotes the formation of blood. But the total quantity in the blood does not exceed 40 grains, and it has been estimated that in health the quantity taken up into the blood per day does not exceed 1 grain, though in some cases of poverty of blood, chlorosis (p. 235), 4 to 5 grains may be taken up and incorporated. The most useful springs will yield from ·14 to ·42 grain of iron in 16 to 48 ounces of mineral water. But food contains iron salts. It is, indeed, from the food that the continual renewal of iron to the blood takes place, flesh meat, yolk of egg, wheat, barley, and lentils, containing considerable proportions of the metal. When this condition of poverty of blood exists, it affects all the bodily functions, and the powers of digestion and assimilation are so enfeebled that full advantage is not taken of the food supplied, and so the condition tends to persist. Under such circumstances the change of air, and the general beneficial influences exerted upon the whole body by the life of the spa, have such stimulating effects upon the nutritive processes that there can be no doubt much of the benefit is due to quite other circumstances than the mere presence of iron in the water drunk. Besides that the presence of other ingredients of the spring, carbonic acid gas, common salt, &c., is stimulating to the stomach and bowels and tends directly to the improvement of the nutrition. It is, at any rate, plain that when such a small total quantity of iron exists in the blood, and such a small quantity is daily made use of, only small doses are necessary. If excessive doses be given, the excess is passed off in the motions as a sulphide of iron, blackening them, and is apt to irritate the stomach and bowels, to interfere with digestion, and to produce constipation. When small doses are given more is actually absorbed into the blood than when large quantities are taken. The conditions, therefore, in which iron springs are most likely to be useful are pretty plain. They are those in which one seeks to promote blood formation, those dependent upon poverty of blood. It has been found that iron springs are most useful in cases of poverty of blood quickly produced, for example, by loss of blood, by bleeding from the nose, or from wounds, by drain occurring from the blood owing to diarrhœa, suppuration, and other profuse discharges, in cases of chlorosis in young girls, and in poverty of blood dependent upon acute disease, in which cases they materially promote convalescence. Iron springs are also used in disorders of monthly illness, specially in its absence, in malarious conditions and poverty of blood due to residence in tropical countries, and in neuralgia, sterility, and impotency due to enfeebled conditions of general health. In such cases as these last the improvement is not so rapid, and is often best promoted by waters which, besides the iron, contain marked quantities of other ingredients like common salt.

It is chiefly in the form of carbonate that the iron exists, and this is the best form for administration. The presence of carbonic acid gas in the water keeps the carbonate of iron in solution, and when the water stands a yellowish rust is deposited.

If constipation be associated with the bloodless condition, a spring should be chosen which contains common salt, or Glauber's or Epsom salts to correct this condition, and if a pure iron spring causes costiveness or diarrhœa and indigestion, a change in a similar direction must be made, such as Marienbad, Franzensbad, Elster.

Iron springs are used for bathing, but it is not now believed that the iron they contain produces any effect upon the skin, or is absorbed from the bath. They have no further effect than baths of plain water, except what is due to the stimulating effect of any carbonic acid

VIII. IRON WATERS (CHALYBEATE SPRINGS).

Name.	Situation.	Altitude in feet.	Ingredients in grains per 16 ozs.				Carbonic Acid Gas in cub. in. per 16 ozs.	Remarks.
			Carbonate of Iron.	Carbonates of Soda, Lime, Magnesia.	Sulphates, Soda, Lime, &c.	Common Salt and other Chlorides		
Alet	Aude, France							
Alexisbad[1]	Harz Mountains	1,350	·35	Only 3 grains other constituents.			10	
Altwasser[1]	Silesia	1,255	·3 to ·7	4 7	½ to 1		4 to 27	
Antogast	Badish Black Forest	1,585	·23	20 grs. other constituents.				
Arapatak	Transylvania		1·16 to 2·35	22 to 24			33	
Bartfeld	North Hungary		·67	16		5	45	
Bocklet (Stahlquelle)	Near Kissingen	620	·67	10	5¾	11	39	
Brückenau[1]	Bavaria	915	·09	1·8	¾		38	Hot.
Bussang	In the Vosges		Table water only. No establishment.					
Cheltenham	England		·88	6 grs. other constituents.				
Cudowa	Silesia	1,235	·2	13	5½		33	Contains also arseniate of iron ·008 to ·012.
Driburg	Westphalia	633	·78	15	22		28	
Elster (see Table III.)			·35					
Flinsberg[1]	Silesia	1,550	·25	Only 2 to 6 grains other ingredients.			27	
Franzensbad	Bohemia	1,293	·3	See Table III.				
Freienwalde[1]	On the Oder		·17 to ·26				little	
Freiersbach	Black Forest	1,280	·7	6½	2		14	
Godesberg	Near Bonn		·2	12		7·3		
Gonten[1]	Appenzell Canton (Switzerland)	2,761	·33					
Griesbach	Baden	1,614	·6	13	8		18	
Harrogate[1]	England	420	Chloride of iron 1·32, carbonate 1·1.			43·9	2 to 2½	
Heinrichsbad	Canton Appenzell	2,410						
Hofgeismar	Hesse	328	·2 to ·4	Only 21 grs. other ingredients.				
Homburg (Stahlbrunnen). See p. 930.								
Imnau	Hohenzollern	1,430	·64	8	½	1¼	30	
Kainzenbad	Bavaria	2,480	See Table V.					
Kœnigswarth[1]	Between Franzensbad and Marienbad	2,000	·4 to ·65	Only 5 to 6 grains other ingredients.			30	
Liebenstein[1]	Thuringian Forest	1,000	·6	6	1½	nearly 2	32	
Liebwerda[1]	Bohemia	1,225	·17	Only 2·5 grains other ingredients.			22	
Lobenstein[1]	Principality of Reuss	1,500	·43					
Muskau[1]	Upper Lusatia (Prus.)	300	Sulphate of iron 1·52, carbonate of iron 1·38.		3½	½	traces	
Niederlangenau[1]	Glatz	1,137	·28	2½	Only 3½ grs. other constituents.		35	
Orezza	Corsica		·85	5			abundant	Traces of arsenic.
Petersthal	Baden	1,333	·35	15	6½	⅓	34	
Pyrmont	Waldeck	400	·37	10½	11	½	29	
Recoaro	North Italy	1,465	·23	5½	14½		18	Lukewarm.
Reinerz	Silesia	1,235	·29	12	½	⅒	35	
Rippoldsau	Baden	1,886	·9	12	8		15	
Santa Catarina	Upper Italy (3 miles from Bormio)	5,600						
Schandau[1]	Saxon Switzerland		·11					
Schwalbach[1] (Stahlbrunnen)	Nassau	900	·64	3½			50	
Shelfanger	Diss, Norfolk, Eng.		·29	2½	·46	·65		
Spa[1] (Pouhon Spring)	Belgium	1,000	·14	Total ingredients 3·9.			8	
St. Moritz	Switzerland	5,710	·2	8	2		31	
Sternberg[1]	Near Prague		·24	Total solids 4·7 grains.			8	
Tunbridge Wells[1]	Kent, England	300	·11					
Vichnye[1]			·95				6	
Wiesau	Bavaria	1.642						
Wildungen	Waldeck	740	·58	See Table VII.			18	

[1] Pure chalybeate waters; others are compound.

gas which may remain in the water after it is heated.

Antogast (1585 feet) is one of the Kniebis baths, which include also Freiersbach, Griesbach, Petersthal, and Rippoldsau. They all lie in the Black Forest, Duchy of Baden, and are reached from stations on the Baden Railway. They vary in the quantities of iron their springs contain, as Table VIII. shows, and they have the advantages of mountain elevation, forest air, and beautiful scenery. They are adapted for all cases of poverty of blood.

Bocklet (620 feet) is only 4 miles north of Kissingen, and the use of its waters is frequently advised after a course at Kissingen. Its spring is advantageous from the combination of common salt and carbonic acid gas with the iron. Bocklet itself is only a small village. Its atmosphere is healthy and invigorating, and from the absence of fashionable amusements it offers a pleasant quiet rural retreat for those who prefer a retired resort. It has a sulphur spring which also contains carbonate of iron to the extent of ·4 of a grain in 16 ounces. The steel springs are two in number, and contain about the same proportion of iron. There is good accommodation in the village as well as in the establishment connected with the springs. It is chiefly resorted to for female disorders.

Harrogate has already been considered under Sulphur Wells (see p. 944). It has also two chief iron springs, the Muspratt and the Tewitt. The latter is a pure chalybeate spring, containing ·135 grain carbonate of iron in 16 ounces. The Muspratt spring, the analysis of which is given on p. 943, is much stronger, and is given in doses of from 2 to 6 ounces three times daily, but it is much more apt to disagree than the water of the weaker spring. The use of these waters has been sufficiently indicated on p. 941.

Orezza is in Corsica, 20 miles from Bastia. "It is in a beautiful country and amidst forests. It is in great repute locally in cases in which iron is indicated, especially in chlorosis and some of the complaints of women, and is said to be a specific in malarious poisoning, which is common in many parts of Corsica, but only when it has not gone the length of producing engorgement of the liver or spleen. Its waters are largely exported. The season is short—from the middle of June to the 30th of August" (Macpherson). It may be used in cases of poverty of blood (anæmia) as a tonic table water.

Pyrmont has already been referred to in regard to its salt springs on p. 929. It was formerly much frequented and very fashionable on account of its iron spring. But it lies only 400 feet above the sea-level, and iron springs which have the advantages of a much higher elevation are now sought in preference, though its waters are well suited for cases where iron treatment is desired, and its arrangements and accommodation are excellent.

Schwalbach is one of the most popular and frequented of iron springs. It lies 951 feet above sea-level in a sheltered valley of the Taunus range, and may be reached by railway from Wiesbaden in an hour and a half. It is one hour's distance by road from Schlangenbad. While it has the benefit of mountain situation it is well sheltered, and its arrangements are excellent. "Everything that has been said of the effects of iron applies to Schwalbach, and there are few wells which answer in their effects to one's expectations better than these" (Macpherson). It has three chief wells—Stahlbrunnen, of which the analysis is given in the table; Weinbrunnen, with ·44 grain carbonate of iron in 16 ounces; and Paulinenbrunnen, with ·51 gr. carbonate of iron. The season is May to October.

Spa is one of the most accessible of continental baths from England. It is reached by a short branch from the railway from Brussels to Liège, the junction station being Pepinster, and the distance from Liège 17 miles. It lies in a beautiful valley of the Ardennes at an elevation of over 1000 feet, 20 miles from Aix-la-Chapelle. Sheltered from the north, it has a mild climate; the surrounding country is attractive; the bathing arrangements are luxurious; and riding on horseback is one of the favourite forms of exercise. It has no less than sixteen springs, the chief, Pouhon, being situated in the centre of the town. Mud-baths are also employed, the material being obtained from the peat soil in the neighbourhood of the town.

St. Moritz (5710 feet) as a health resort has been sufficiently spoken of on p. 796. Its steel springs are tolerably pure, and are pleasant from the abundance of gas they contain. Baths are also to be had. But the waters and baths are really secondary considerations in a residence at St. Moritz, the bracing effect of the mountain air and the magnificent scenery being the chief attractions for the large numbers who seek the restorative influences of this favourite resort.

Tunbridge Wells, 30 miles south of London, possesses a fairly pure steel spring. Its climate is healthy and bracing and its surroundings beautiful. Its waters are not taken advantage of to the extent they might be. Weber suggests that the addition of Selters or Apollinaris might make them more useful for some constitutions, because of the stimulating effect which the carbonic acid gas either of these table waters would supply.

IX. Iodine Waters.

A considerable number of the waters we have noticed contain minute quantities of iodine as iodide of sodium or magnesium, and also bromine in similar combinations. To the presence of this ingredient much value was attached, especially in the treatment of scrofula in children, and in various other complaints. The springs which were specially classed as iodine or bromo-iodine waters were the Adelheids spring (p. 929), Dürkheim (p. 929), Hall (p. 929), Kreuznach (p. 931), Wildegg (p. 929), and Woodhall (p. 932). The quantity of the iodine compound is in every case so small that it is not now believed that it can produce any perceptible effect upon the body, except perhaps in the case of Woodhall. The waters are usually rich in other saline ingredients, to which their good effects are now attributed, and they have accordingly been noticed elsewhere.

X. Arsenical Waters.

What has been said of iodine waters is equally true of arsenical waters. The presence of minute quantities of arsenic is found in several waters, but the chief are La Bourboule (p. 940), St. Dominique (of Vals), and Mont Dore (p. 937). It has been estimated that to get a medicinal dose of arsenic 4 to 8 pints of the water would require to be taken daily, and as a rule the effect of this ingredient is scarcely calculated upon.

Court St. Etienne water, from a spring near Waterloo, in Belgium, discovered in 1878, is said to be one of the strongest and most permanent of arsenical waters. Tichborne's analysis gives ·083 grain arseniate of soda in 16 ounces, and this amount of arsenical salt is associated with less than 2 grains of other ingredients, so that it might be used as a pure arsenical water in cases where arsenic seemed indicated (see p. 823).

The Whey-cure.

The whey-cure is a method of treatment adopted at many health resorts, the whey being either sipped alone at a temperature of about 105° F., while the patient takes gentle exercise, or being added to the mineral water of the resort. In the former case not less than a pint daily is the quantity consumed, and from 4 or 6 pints are the largest quantities ordered. The whey is taken in the early morning, and breakfast is not taken till after an interval of an hour or more. In the chief whey establishments goats' milk is used for the production of the whey. The nature of whey has been explained on p. 550. It is milk deprived of its casein or curd, and most of its fat or butter. It thus contains a small quantity of albuminous material, a little fat (the clearer it is the less fat it contains), the sugar of milk, and the salts of milk (p. 551), chlorides, sulphates, and phosphates. The value of the whey is attributed partly to the sugar, and partly to the salts. The whey has a slight opening effect on the bowels, but is also apt to cause dyspepsia and catarrh of the bowels. The whey-cure is specially ordered for consumptive patients, and for persons with much cough, and irritation of the windpipe and large bronchial tubes. But these are just the cases which are now sent to mountain resorts, where indeed the chief whey establishments are, and the improvement effected is mainly due to the fresh mountain air. Braun doubts whether whey is not actually less useful than well-adapted courses of mineral waters, like those of Carlsbad or Marienbad, which stimulate stomach and bowels, and aid the appetite and digestion without producing catarrh.

Whey is to be had at nearly every mineral spa, but those which have a special repute in this way are stated below.

Alexisbad (p. 949).

Arco, in the Southern Tyrol.

Baden, near Vienna (p. 943).

Driburg (p. 949).

Elster (p. 934).

Ems (see p. 940).

Engelberg (canton Unterwalden, Switzerland), 3180 feet above the sea, reached from Lucerne.

Gais, in the canton Appenzell, 3064 feet above the sea.

Gleisweiler, 1000 feet above the sea, one hour from Landau in the Lower Palatinate.

Heiden, in canton Appenzell, Switzerland, 2645 feet above sea-level.

Heinrichsbad (p. 949).

Interlaken, Switzerland, 1863 feet above sea-level.

Ischl (p. 929).

Kreuth (p. 929).

Liebenstein (p. 949).

Meran (p. 797).

Montreux, 1186 feet above the sea, on the Lake of Geneva, near Vevey.

Rehburg, in Hanover, which has also saline and iron springs.

Reichenhall (p. 929).

Reinerz (p. 949).

Roznau, in Moravia, 1200 feet above sea-level.

Salzbrunn (p. 937).

Schlangenbad (p. 926).

Soden, in Nassau (p. 929).

Streitberg, in Bavaria, 1800 feet.

Waggis, at the base of the Righi, on Lake Lucerne, at an elevation of 1434 feet.

Weissbad, canton Appenzell, Switzerland, 2320 feet above the sea.

Most of these places, specially those of Switzerland, are favourite health resorts in summer, and many of them suitable for consumptive patients.

The Grape-cure.

The grape-cure has been referred to on p. 576, and in speaking of Meran on p. 797. Taken in quantity on an empty stomach grapes act upon the bowels, stimulate change of substance, and at the same time supply sugar and salts to the blood. From 1 to 8 pounds are consumed per day, partly taken before breakfast, and partly throughout the day. They are used for their opening effect in cases of sluggishness of abdominal organs and corpulence, and in lung affections for their stimulus to the general nourishment of the body. Braun says of this method of treatment, "All, however, that has been said of the whey-cure applies still more to the grape-cure. Dyspepsia and catarrh of the bowels are constantly the results of the treatment, and a case seldom occurs in which the object could not have been better obtained by means of courses of mineral waters without any of these injurious symptoms."

The best-known resorts for the grape-cure are named below:—

Arco, in the Southern Tyrol, 288 feet above the sea, three-quarters of an hour from Riva, on Lake Garda, and two hours' journey from the Mori station. The season is from October to May, and the place is well suited for cases of consumption.

Bex (see p. 929).

Bozen, in the Tyrol, a town of 10,000 inhabitants, a station on the railway from Munich to Verona. Meran is on the same line.

Dürkheim (p. 929).

Edenkoben, in the Haardt Mountains.

Gleisweiler (p. 951).

Grünberg, in Silesia. **Meran** (p. 797).

Kreuznach (p. 931). **Montreux** (p. 951).

Rheinfelden, in the canton Aargau, Switzerland, at an elevation of 866 feet.

Vevey, canton Vaud, Switzerland; elevation 1263 feet. On the Lake of Geneva.

Any one desiring further details of mineral baths and wells, &c., should consult *Curative Effects of Baths and Waters*, by Dr. Julius Braun, translated by Dr. Hermann Weber, *The Baths and Wells of Europe*, by Dr. John Macpherson, or *The Mineral Waters of Europe*, by Drs. C. R. C. Tichborne and Prosser James.

SECTION XI.—THE MEDICAL USES OF ELECTRICITY.

The Medical Uses of Electricity.

Electricity has of late years been much employed in the treatment of disease. The benefits derived from it when it is properly employed are in many cases of a very remarkable kind, and for many diseases it affords almost the only hopeful means of treatment. There are now many workers in this department of medicine, and the employment of this agent is becoming yearly more and more extended. Still, the effects of electricity are not well understood, and much remains to be done before this agent, powerful though it undoubtedly is, can become commonly used. It ought to be said that the regular employment of electricity by medical men has nothing in common with the use of magnetic appliances, electropathic belts, and so on, which, so far as is at present known, are entirely valueless. It is the electric current, as generated by the usual forms of batteries, to which reference is made in this section. Two kinds of current are chiefly used: (1) that directly obtained from cells, associated together in the form of a battery, which is a **constant current**, and may be allowed to flow through the part of the body to be acted upon for a certain length of time continuously, or may be interrupted slowly or quickly by a suitable appliance; and (2) that obtained from a coil of wire, in the immediate neighbourhood of another coil through which a current from one or more cells is passing. The first is the ordinary **galvanic current**, or **constant current**; the second is the **induced current**, or the **Faradic current**.

One of the chief purposes for which electricity is used is for stimulating paralysed muscles and nerves. In cases of paralysis from nervous disease, or from lead-poisoning, or from the effect of diphtheria, or in cases of paralysis of a nerve from cold, for example paralysis of one side of the face, treatment by electricity is one of the chief methods of cure. The current from battery or induction-coil is applied directly to the affected muscles or nerves. Holding the handles of the battery or induction-coil so as to permit the electricity to flow through the body is in no case of much use. The wires from the coil or battery are usually connected with button-like pieces of brass attached to wooden handles, and covered with chamois leather. The leather is soaked in salt water, and the skin over the part to be acted upon is also well moistened with the salt water. These handles with their brass ends are called **electrodes** or **terminals,** and the actual shape and size of the brass piece depends upon the part to which it is to be applied. One electrode is usually placed on an indifferent part of the body, the nape of the neck or some part of the back, and the other is placed over the part to be acted on. The current is then allowed to pass; and if from a battery it may be allowed to flow continuously by keeping the electrodes steadily applied, or it may be interrupted and sent on again by lifting one electrode and then reapplying it. It is when interrupted in this way that the current is most stimulating; and this method of application is employed in paralysis of muscle or nerve. The most stimulating current is the induced current, since it is not a continuous stream but a rapid series of shocks. When a paralysed limb is being treated it is of little use to pass the current through the whole limb at once, but the limb must be gone over bit by bit, each muscle being in turn stimulated to contract, the movement produced being quite visible, and for this purpose anatomical knowledge of the position of the various muscles and the nerves supplying them is of course required.

The stimulating effects of the induced electrical current are made use of in some skin diseases, in some chronic scaly diseases for example. The same effects are brought into play to stimulate the growth of hair on bald patches, such as from the disease of hair known as alopecia areata (p. 329). In such a case one electrode of the kind described, well moistened, is placed on the nape of the neck, and the second is in the shape of a fine wire brush, with which the bald spot is brushed.

Electricity may be employed for the relief of pain, neuralgia for example. For this a weak constant current is used, the electrode connected with the negative pole of a battery is placed, well moistened, over the nape of the neck, and that connected with the positive pole, also well moistened, over the painful spot, and the current allowed to flow steadily for a few minutes. Ovarian pain (p. 507) is thus frequently successfully treated. Painful rheumatic joints may be relieved in a similar way, and sometimes by the induced current applied over the skin of the affected joint by the dry wire brush. The passage of the constant current through a chronic rheumatic joint is often attended by much relief, not only by the soothing effects of the current, but also because it induces beneficial changes in the nutrition of the joint, leading to the renewal of thickenings and swellings.

In hysterical affections electricity employed in association with massage (p. 772) is one of the most important of modern methods of treatment.

Electricity is becoming more and more made use of in nervous affections connected with the brain and spinal cord, and in mental disease, especially in melancholia, there is a great future in store for this method of treatment. The writer has had in his own experience a few very remarkable instances, where complete removal of the mental disorder followed the employment of a weak constant current of electricity to the brain. In such cases, of course, the remedy requires to be very cautiously applied, and could not be ventured upon by any one not well acquainted with the proper method of application.

In surgery the electrical current is made use of for the removal of small tumours and growths. In such cases a current is used sufficient to bring platinum wire to a red heat, the growth being destroyed by being touched with the glowing point, or the tumour being removed by being encircled with the red-hot wire. The advantage of electricity over the ordinary cautery being that the platinum point or wire may be properly adjusted cold, and then the current sent on to make it hot.

In cases of aneurism (p. 244) needles, connected with a battery, are passed into the sac of the aneurism, and the electric current by decomposing the blood in the tumour promotes the formation of a clot.

In eye surgery electricity is made use of to remove pieces of steel from the eye by rendering a steel point magnetic.

These are but a few illustrations of the value of this physical agent in the treatment of disease. Many more might be given. But so much special knowledge is required to enable one to employ such an agent with success and without risk, that no advantage is to be gained from entering into fuller details.

SECTION XII.—THE USE OF ANIMAL EXTRACTS IN MEDICINE.

Within the last few years great additions have been made to the number of remedies employed in the treatment of disease. In two directions specially valuable progress has been made. One of these is in the employment of preparations made from certain organs or tissues of the lower animals, and the other is in the extension of a process, akin to that of vaccination, by which a person is protected against, or cured of, an infectious disease, by injecting into his body, under the skin, some of the blood obtained from an animal previously made refractory to the particular disease in question.

The former class of remedies is called **animal extracts**, and the latter class **anti-toxins**, and the reason of these terms will be immediately apparent.

Animal Extracts.—Pepsin and pancreatin, described on pp. 845, 846, are animal extracts. They may be extracted, the one from the stomach, the other from the pancreas or sweetbread, of the pig or calf, by soaking pieces of the organ in glycerine or alcohol. They are ferments whose action is understood, and can be carried on outside the body as well as within it. But the new variety of animal extracts, which may be made also by steeping pieces of the desired organ in glycerine, produce their effects only when introduced into the body. Their action is not, so far as is known, due to ferments, it cannot be imitated outside of the body, and their effects are best seen in diseased conditions of the body, when they seem, in a manner not yet understood, to assist some function of the body not being properly carried on. The typical illustration of the use of such extracts is a disease called **myxœdema**. This affection seems to be dependent on disease of the thyroid gland in the neck. In it there is marked increase in the general bulk of the body. The skin is swollen as if it were dropsical, but the swelling is firm and solid, and does not pit on pressure as dropsical swellings do. The skin becomes dry and rough; the face loses its expression; hair falls out, so that the patient becomes bald; the utterance becomes slurring; the quality of the voice altered; movement becomes slow, and also thought; memory defective. The temperature of the body is lowered. These changes go on slowly, so slowly as to take years to become very obvious. In such patients the thyroid gland is diseased or atrophied. The symptoms of the disease may be produced in animals by the removal of this organ. Now, this disease was believed to be incurable, till its relation to the thyroid gland began to be suspected. The first result of this idea was the suggestion of grafting the healthy thyroid gland, just removed from an animal, into the body of the patient, in the hope that if it could be done successfully, the transplanted organ might perform the function the diseased organ had failed to do. Success was obtained. The next step in advance was made when it was found that excellent results followed the administration to the patient, by the mouth, of the fresh thyroid gland of a calf or lamb, finely chopped up. Glycerine extracts were then made use of, and proved of equal value. The gland is now used mainly in the form of tabloids, made of the dried gland compressed. These keep very well, and, swallowed whole, are practically tasteless. In a pronounced case of myxœdema, the effects of the treatment are of a most amazing kind. In a few days the solid swelling begins to diminish with great rapidity, and all the other symptoms to disappear. Even the hair is restored. But the remedy must be given with care, for its effects are sometimes alarming. Nausea, loss of appetite, loss of strength, and indeed great prostration are quite common results if the treatment be carried out too rapidly or too long. But, with care in the administration of the remedy, no evil need be feared. From a quarter to a half of the fresh gland may be given daily, and the dose gradually increased as seems desirable. The tabloids are a very convenient means of administration, at the beginning half a tabloid being given twice or thrice daily, and the dose being gradually increased. After all symptoms of the disease have disappeared the treatment may be stopped for a time, but it is, as a rule, necessary to maintain the condition of health by a short course of the treatment at intervals.

Thyroid extract or tabloids have been found valuable in other disorders. In the disease called cretinism (p. 211) equally remarkable results have been obtained. The remedy has been successfully employed in certain skin diseases, specially psoriasis and lupus, in obesity, and in a very rare disease called **acromegaly**, characterized by the enormous size to which the hands and feet grow. In some forms of insanity benefit of a most remarkable kind has been obtained by thyroid treatment.

Now, these results opened up a new departure in the treatment of disease. The medicinal value of other organs, used raw, or in extract or tabloid, was investigated, and with some result. Before the discovery of the use of thyroid in myxœdema, Brown-Séquard of Paris had advocated the use of certain organic extracts in nervous disorders, and in such diseases ovarian substance and testicular substances, also obtainable in tabloid form, have since been successfully administered.

In certain forms of bloodlessness the use of the red marrow of bone has been suggested and favourably reported on. It also may be obtained in tabloid form, but it is easily procured fresh from the butcher. If one of the short bones of a lamb or calf be split in its length, the red marrow is lifted out by a spoon. It may then be made up with jelly, or, with salt and spice, spread on thin bread and so eaten. Extract of suprarenal capsules, of spleen, of the thymus gland and pituitary body have also been added to the list of remedial agents. From brain tissue, powders called cerebrin and cerebrinin have been prepared, whose value in headache, sleeplessness, and other nervous disturbances is considerable.

Anti-toxins.—In Section XIII. of the first part of this work the relation between living organisms and disease has been pointed out. Some account has also been given of Pasteur's work, and specially in the search of means to combat such diseases. It has been explained, on p. 392, how Pasteur was able to prepare an inoculating fluid which would protect animals against splenic fever. Animals which have thus been protected against an infectious disease are said to be **immune**, and the process is called **immunization**. It is well known how the latest triumph of Pasteur was obtained in the investigation of hydrophobia. From the spinal cord of animals who had suffered from hydrophobia, he was able to prepare a fluid, which, injected under the skin of persons who had been bitten by a mad dog, protected them from this disease. Such a preparation is called an **anti-toxin**, from the Greek words *anti*, against, and *toxikon*, poison. Some years ago Koch, pursuing his investigations into tuberculosis, the disease of which consumption is a variety, due to the action of an organism, the tubercle bacillus, believed he had discovered a remedy for the disease. The remedy was obtained by making a pure cultivation of the tubercle bacillus, and straining off the fluid in which it had been grown. This fluid injected under the skin of tuberculous patients, it was believed by him, would cure the disease. His anticipations have not been fully accomplished, though the preparation thus obtained has, nevertheless, proved to be of great value. It has been found, for instance, that certain marked effects were produced in patients who suffered from any form of tuberculosis, when this substance, called **tuberculin**, was injected, and that they did not follow in the case of persons unaffected by tubercle. The same has been found true in the case of animals. Now tuberculosis is one of the commonest of diseases in cattle, and from cattle it may be communicated to human beings by the use of tuberculous meat, or by the use of milk from tuberculous cows. But often ordinary methods fail to indicate when an animal is tuberculous. The use of Koch's preparation will enable tuberculosis to be discovered in cattle, and so dairy-farmers and stock-raisers have had put into their hands a valuable means of preventing diseased animals being added to their stock.

But though an anti-toxin which shall render a person immune to consumption has not yet been found, success has been achieved in the case of other diseases. The chief instance is that of diphtheria. Why does one attack of an infectious disease protect the patient against a second, or, at least, render the patient much less susceptible? The theory is that the infective organism produces certain substances, in the course of its activity, in the blood and tissues of the patient, which act as poisons to the tissues, but that other substances are also produced, in time, which are antagonistic to these poisonous substances and so arrest their further action. Now if these antagonistic substances could be produced at will, and injected into the body of a person who had been exposed to the particular infection, or was suffering from the disease, the poison of the disease would be antagonized and the patient cured. This is briefly the theory of the antitoxic treatment of infectious disease. The result has been successfully achieved in the case of diphtheria, the anti-toxin being prepared from the blood of a horse rendered immune. In thousands of cases this remedy has been employed, with the result of a great reduction in the mortality from the disease.

Anti-toxins have also been prepared for erysipelas, tetanus, certain forms of blood-poisoning, and for the poison of snake-bite.

PART IV.

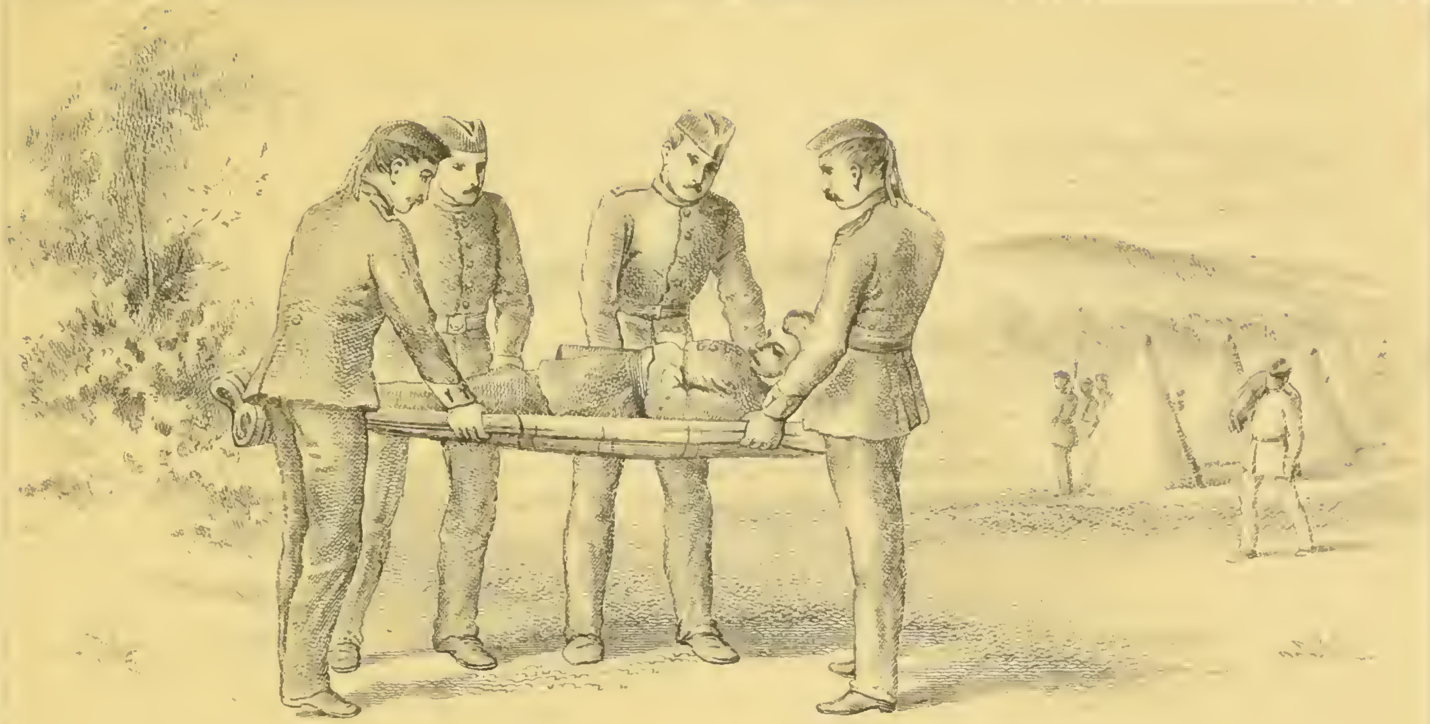
BANDAGING: ACCIDENTS AND EMERGENCIES: FIRST AID TO INJURED: MINOR SURGERY, AND MEDICAL AND SURGICAL APPLIANCES.

SECTION I.—BANDAGING.

- **The Uses of Bandages:**
  - *Rules for Bandaging;*
  - *The Material for Bandages;*
  - *Method of Applying the Bandage.*
- **Varieties of Turns for the Bandage:**
  - *The Simple Spiral;*
  - *The Reversed Spiral;*
  - *The Figure-of-8.*
- **Bandage for the Hand and Arm.**
- **Bandage for the Fingers and Thumb.**
- **Bandage for the Shoulder:**
  - *The Spica of the Shoulder.*
- **Bandage for the Foot and Leg:**
  - *Bandage for the Heel.*
- **Bandage for the Groin:**
  - *The Spica of the Groin.*
- **To Bandage the Breast and Chest.**
- **The T-shaped, Double-T, Four-tailed, and Many-tailed Bandages·**
  - *The* T *applied to the Chin and Head.*
- **Bandages for the Head:**
  - *The Capelline and Twisted or Knotted Head Bandages;*
  - *Simple Bandage for the Head; the Shawl Cap.*
- **Starch and Plaster of Paris Bandages.**
- **The Triangular Bandage:**
  - *Its Use as a Sling;*
  - *Its Application as a Hand, Arm, Shoulder, Chest, Back, Foot, or Knee Bandage;*
  - *Its Application to the Groin.*
- **The Knotting of Bandages:**
  - *The Granny and Reef Knots;*
  - *The Clove Hitch.*

The Uses of Bandages.—Bandages are employed for a variety of purposes. One of their chief uses is to secure dressings or splints. Another is to give support to a limb or to restrain its movements, or to exert pressure upon it to aid in restraining bleeding at some point, or to promote healing as in the case of ulcers, or to aid in the removal of swelling. In these latter cases the bandage must be applied with a considerable degree of tightness, and great care must be exercised that the bandage is evenly put on, and that the tightness with which it is drawn does not give rise to disturbance of the circulation by undue and irregular pressure. This is a point well worthy of particular attention. Suppose the arm is being bandaged from the hand well up over the upper arm. The arteries which carry the blood down the limb are for the most part deeply seated and well protected by muscles, so that they are practically unaffected by any ordinary degree of pressure on the surface. But many of the veins which carry the blood back to the heart up the limb run immediately under the skin, and will be pressed upon considerably by a bandage applied round the arm. Suppose such a bandage applied loosely from the hand up near to the elbow, and suppose when the elbow is approached the bandage is pulled much more tightly, what is certain to be the result? The veins near the elbow will be compressed, the blood will flow less easily along them at that point than it does lower down where the pressure is less. The consequence will be that the blood will be hindered in passing up from the hand; and as blood is all the time being carried

EMERGENCY METHODS OF CARRYING INJURED PERSONS.



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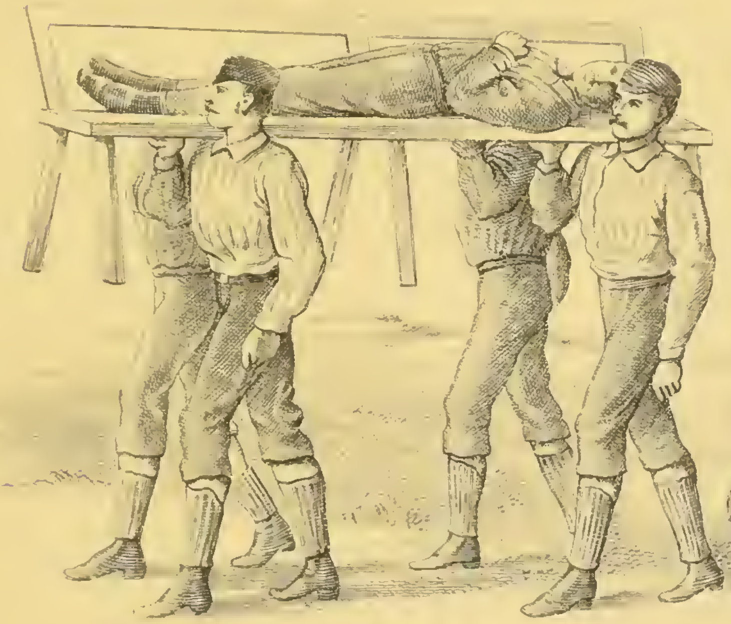

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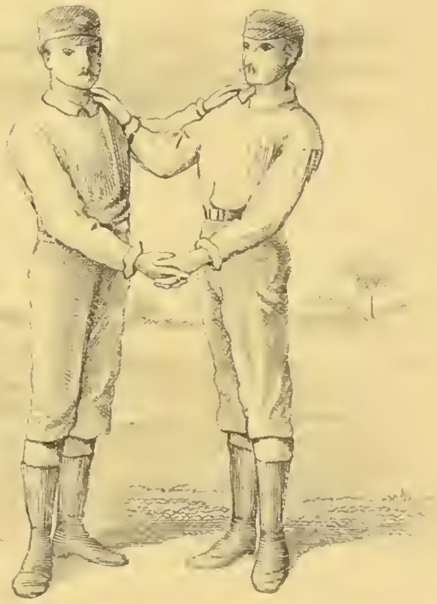

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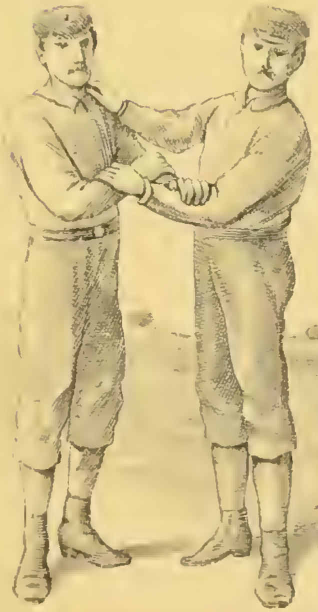

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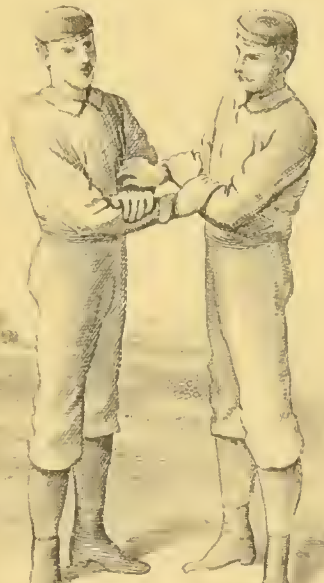

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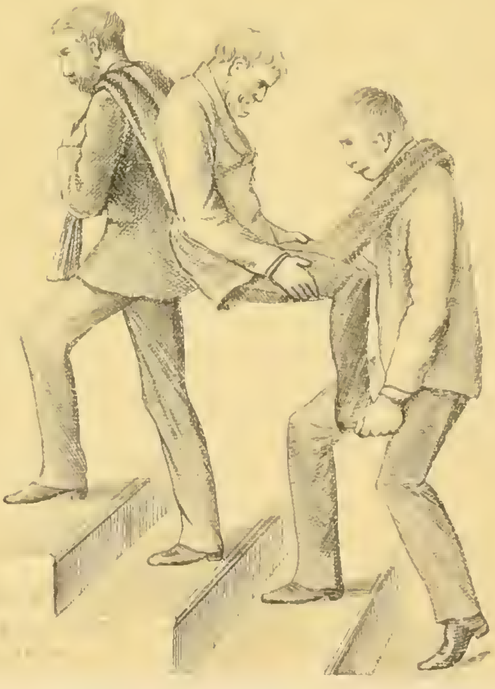


6 A

down to the hand in the arteries, which are unaffected, the veins in the forearm and hand below the tight turns of the bandage will become swollen and gorged with blood. The pressure of blood in the veins will become so great that fluid will be pressed out of the finer vessels into the surrounding tissues, and the hand will become swollen, puffy, and dropsical, while much pain will be experienced. If the tight turns of the bandage are now loosened, the veins will again offer a free passage to the blood, the activity of the circulation will be restored, and the swelling and pain will gradually subside and disappear. Now the results that have been described are exceedingly commonly witnessed as the result of bad bandaging, and it may take days for a hand to recover from the effects of a bandage thus improperly applied. What are the means of preventing such a state of affairs? Bandage loosely, one might say; but a loose bandage may be useless. The proper means of preventing it is to bandage *uniformly*, not to bandage tightly here and loosely there, but to begin with the requisite degree of tightness *at the very extremity of the limb*, and to bandage so evenly and regularly upwards. If any difference is permitted, it should be in the direction of allowing a somewhat less degree of tightness to be given to the turns of the bandage as they pass up. Any required degree of tightness may be given to the turns provided it begins from the extremity. For in such a case the veins are uniformly compressed from below up. They are really made channels of smaller diameter throughout. This does not hinder the return of blood; it simply causes the flow along the narrower channels to be faster than it would have been along the wider ones. But wherever a wide channel suddenly becomes narrowed, then the current becomes impeded and stagnation tends to arise.

Rules for Bandaging.—The first rule then in bandaging a limb is, *Never let the bandage be tighter high up the limb than it is at the extremity; apply it firmly and evenly at the extremity, and let it be carried up uniformly*, if anything allowing it to be a little easier as one proceeds. Now if this be understood, the reason of several rules regularly followed will be apparent. Suppose one has to bandage the upper arm. If a bandage be rolled round the limb simply at the place where it is immediately required, it is plain that the veins at this place will be compressed if the bandage is at all tightly applied, and the forearm and hand will swell. The rule, therefore, is, begin the bandage at the hand and proceed regularly up the limb till the part is reached which one specially desires to cover. We may therefore state as a second rule, that *if a bandage requires to be tightly applied in the course of a limb, the bandage must be begun at the extremity.* Of course if the bandage is to be applied quite loosely it is not necessary to begin at the extremity. It is specially necessary to follow these rules when the bandage is applied to secure a splint, since it must be tight enough to keep the splint in accurate position, or to keep a pad firmly applied over a wound for the arrest of bleeding. A good illustration of the support a properly-applied bandage gives to the circulation is in the case of varicose veins of the leg. The great swelling, dropsy, and pain may be almost entirely removed, at least very greatly relieved, by a bandage being put on with considerable tightness from the toes upwards.

When it is desired to exert very considerable pressure upon a part for a length of time, or when it is desired to keep a limb or a joint motionless for some time, this may be done without the use of splints by stiffening the bandage with starch or plaster of Paris in a way to be described.

The Material for Bandages usually consists of strips of unbleached or bleached calico, linen, flannel, or of muslin, or open web, crinoline or cheese-cloth. Elastic bandages and india-rubber bandages are in use for particular cases. The material should be torn into the strips of the requisite breadth; they should have no hem or edging, as this would prevent them stretching equally in all directions. The strips should be rolled up for use into firm **rollers**. A roller bandage is usually 6 yards long, but may be 8 or 12 yards. They are of different breadths according to the part to which they are to be applied. The commonest size is 2½ and 3½ inches, the former being the size suited for the arms and head, the latter for the legs and groin. For the chest and abdomen a width of 4½ inches is best. For the finger the strip should be ¾ in. wide.

Method of Applying the Bandage.—Lay its *outer* side against the part, and let it be unrolled no more than 3 or 4 inches in advance. In the case of bandaging a limb the person should stand opposite the patient and begin on the *inner*, not the outer, side of the limb carrying the bandage from the inner side outwards over the limb.

Varieties of Turns.—There are various methods of making the turns of the bandage so that they lie smoothly and press equally. The **simple spiral** is that form in which one turn simply overlaps the previous one to about half its breadth. This is the turn with which one very often begins a bandage, but it cannot be carried on very far, because the inequalities of the limb, the rapid thickening of the arm from the wrist upwards, for example, prevent each turn lying closely and evenly over its neighbour. A second kind of turn requires then to be used, called the **reversed spiral**. It is shown in its application to the arm on Fig. 339. As soon as it becomes necessary to make use of the reverse, the thumb of the left hand, which is supporting the limb, is placed on the lower edge of the last turn to fix it. The upper border of the turn is then folded down by turning the roller over in the hand, the roller being held quite slack while this is done. The roller is then carried round the limb till it comes opposite the place where the reverse was made and the manœuvre is repeated. So one reverse after another is made, so long as is necessary. The position of one reverse should be accurately in line with its neighbours as shown in the figure; and if the bandaging is well done it looks exceedingly neat and tidy. When the enlargement of the limb is too great to permit even the reverse to lie evenly a third variety of turn is resorted to, the **figure-of-8**. This turn is required to cover joints such as the ankle, elbow, and knee smoothly. It is shown in its application to the elbow in Fig. 340. The bandage is carried alternately up and down the limb; the figure shows it after it has been carried up the limb and is on the point of being brought down. A figure-of-8 loop is actually produced. To do this turn successfully the loops should be made wide, the bandage being carried in a good slope upwards, and then down. When completed the bandage is hardly distinguishable from the ordinary reverse. (Compare Figs. 339 and 340.) Now these varieties of turn may all require to be used in the course of applying one bandage to a limb, the expert using one turn or another as is most suited to the shape of the limb, and producing as a result a firm, well-fitting, and neat-looking piece of work. The figure-of-8 bandage requires twice as much material to cover a limb as the simple spiral, and it is generally limited to turning round joints. When it is desired to cover the heel or elbow alone this is the turn adopted, the end of the bandage being laid over the point of the heel or elbow. The first turn would simply surround the joint, then starting from this the loops would gradually widen out, covering the joint as they proceeded, the loops crossing in front.

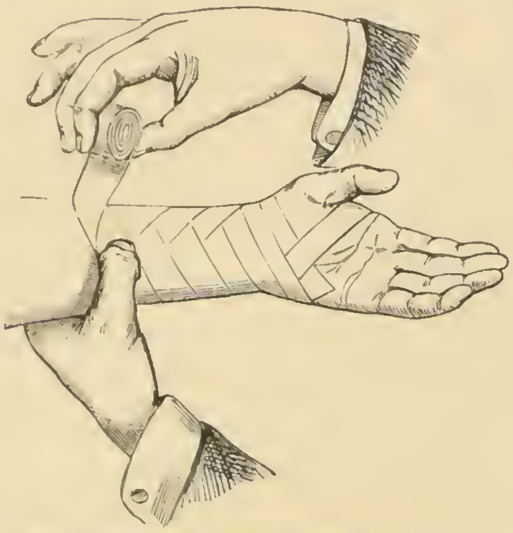


Fig. 339.—The Reversed Spiral Bandage.

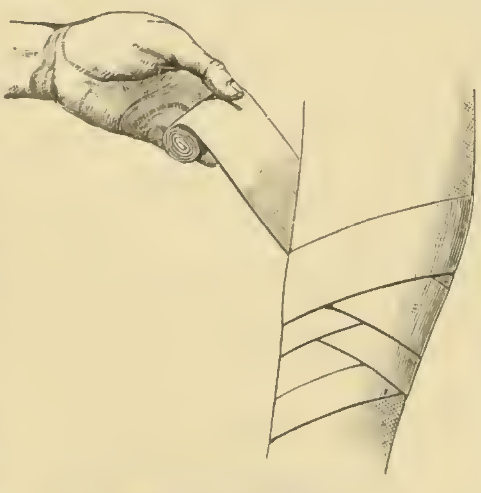


Fig. 340.—Figure-of-8 Bandage.

Bandage for the Hand and Arm.—A bandage 2½ inches in width is used. Begin by laying the end across the back of the hand, the outer surface being next the skin, carry the bandage round the root of the little finger to the palm, across it, passing between the thumb and forefinger, where it meets and fixes down the end. From here the bandage is carried across the back of the hand upwards to the wrist, round the front of the wrist, and when it reaches the thumb side of the wrist it is carried again across the back of the hand but *downwards* towards the root of the little finger, round to the palm, which it again crosses to the space between the forefinger and thumb, from which it is again carried upwards to the wrist. This is a figure-of-8 turn, and several such turns are taken, each overlapping the other at a proper distance, and the turns being drawn pretty tight, till the palm and back of the hand are covered. It is well to put a little cotton-wool in the palm before the turns are made. Two or three simple spiral turns are then made from the wrist upwards, till it becomes necessary to use the reverse; at the elbow the turn is changed to the figure-of-8, and when it is covered, the simple spiral aided by a few reverses will carry the bandage well up towards the arm-pit. Before the turns are made round the elbow, a little piece of cotton-wool should be placed on the bend of the elbow and another small piece on the inner edge of the joint, to protect the bony edge. Of course it may not be necessary to carry the bandage farther up than the lower edge of the elbow joint.

Bandage for the Fingers.—For the fingers a bandage ¾ths of an inch broad is required. Lay the outer surface of the bandage on the front of the wrist, carry it once round the wrist to fix it, passing over the thumb side of the wrist first. When it comes round to this position again, carry the bandage across the back of the hand and right up to the tip of the finger with a few turns. From the tip slowly return down the finger, each turn overlapping the other to the proper extent, reverses being used, till the root of the finger is reached. Then take the bandage across the back of the hand to the wrist and fix it there by one or two turns. If more than one finger requires bandaging, after returning the bandage to the wrist and passing it once round, take it across the back of the hand again to the next finger, and treat it as before. In this way each finger may be bandaged with the same roller. The thumb is treated in a similar manner. This is shown in Fig. 341. One finger is shown in Fig. 342, bandaged with a few simple spiral turns, without any reverse.

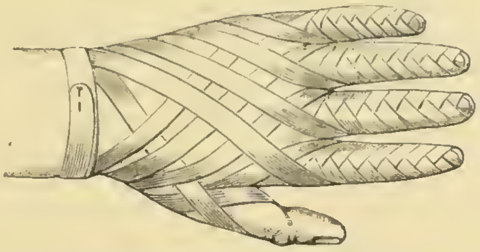


Fig. 341.—Reversed Spiral Bandage for Fingers.

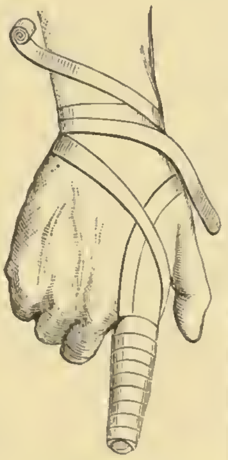


Fig. 342.—Spiral Bandage for Finger.

To bandage the thumb fix the roller by a turn round the wrist, then carry the bandage straight to the tip of the thumb, make one or two turns round the tip, and then descend by reverses to the first knuckle joint. Here the kind of turn is changed in order to cover the ball of the thumb properly. The bandage is carried across the back of the hand, round the wrist, then up round the ball of the thumb, across the back of the hand once more, round the wrist, again up round the ball of the thumb, and again down to the wrist, making a series of figure-of-8 loops, till the whole is covered in. Fig. 343 shows this arrangement, but without showing the tip of the thumb covered. In many cases when it is desired to cover only the ball of the thumb, the bandage to the tip is dispensed with.

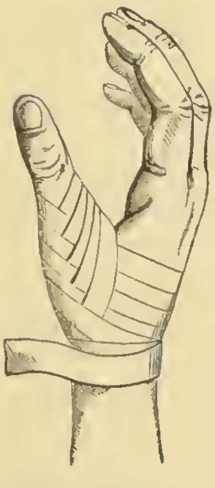


Fig. 343.—Figure-of-8 Bandage for Thumb.

Bandage for the Shoulder.—This bandage is called the spica of the shoulder. A few turns of the roller are taken round the upper arm to fix the bandage, which is then carried up in front of the shoulder, over which it passes high up, then across the back to the opposite arm-pit, where it passes under the arm and over the front of the chest to the top of the shoulder again. Here it is turned down and passed under the arm-pit from which it started, and is brought up in front as at the beginning. Another turn of the course described is taken, and another and another, each turn partially overlapping the one preceding, and each coming lower and lower till the whole shoulder is covered in, when the bandage is finished off by a turn or two round the chest. This, it will be seen, is simply a figure-of-8 bandage. This is the usual method. A little cotton-wool is placed in both arm-pits to avoid chafing by the turns of the bandage. Fig. 344 shows the appearance of the shoulder when the bandage is finished. But in this particular instance the bandaging of the upper arm has been begun from behind, and the bandage has been brought round the outer side of the arm, carried straight across the chest to the opposite arm-pit, carried under it across the back to the top of the shoulder to be covered, then down in front to the arm-pit from which the bandage started, under it and round the back of the arm, and thence across the chest as before.

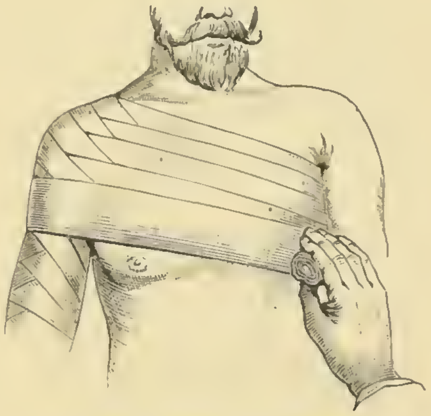


Fig. 344.—Spica of the Shoulder.

Bandage for the Foot and Leg.—A 2½-inch roller is used. The foot and leg are bandaged in a way similar to that described for the hand

and arm. Place the end of the bandage on the sole of the foot, carry the bandage up on the inner side of the foot and across the back to the outer side of the ankle, carry it round the ankle, and back across the foot to the outer side at the root of the little toe, down across the sole, and up again on the inner side. This prevents the bandage slipping. Then carry the bandage down the foot with reversed spirals till the heel is reached. There it is carried firmly up the inner side of the instep, and when it reaches the front it is taken round the ankle. The heel is thus not covered in at all. From the ankle the bandage is carried up the leg, by simple spirals up the small of the leg, and then by reversed spirals up the calf, and finished off below the knee-pan (Fig. 345). If the heel is to be covered it may be done by loops of the figure-of-8 turn. When it is necessary to cover the knee the figure-of-8 is also used. The combination of simple spiral and reversed spiral will carry the bandage up the thigh.

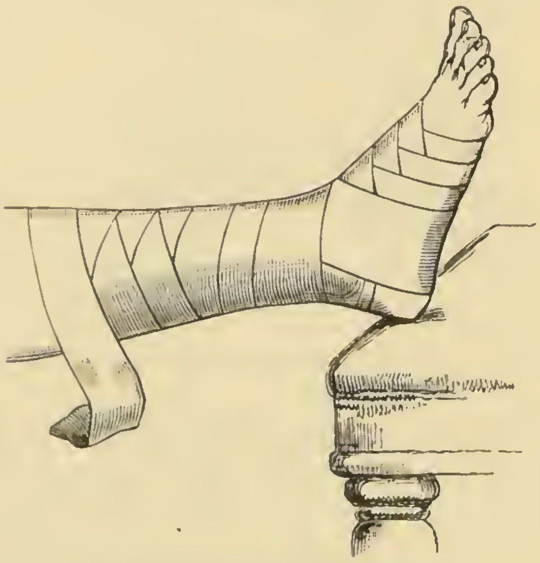


Fig. 345.—Foot and Leg Bandage.

To cover the heel only, a broad bandage 3 inches or more is needed. Lay the end of the roller on the front of the ankle, and carry the bandage round the outer side, passing it over the point of the heel, which should accurately rest on the middle of the bandage. Complete the turn by bringing the bandage up the inner side of the heel to the front. The roller is then carried in figure-of-8 loops round the ankle, then across the back of the foot to the outer side of the sole, across it, up on the inner side; and it is then slanted upwards round the ankle again. Each turn half overlaps its neighbour, and thus the bandage passes up the small of the leg on one side and down towards the toes on the other till the whole joint is covered in.

Bandage for the Groin.—A bandage 2½ to 3 inches wide is required. The groin is covered by a series of figure-of-8 loops like the shoulder. The arrangement is called the **spica of the groin.** It is shown in Fig. 346. Two or three turns, simple or reversed, are taken round the top of the thigh, passing from within outwards. The bandage is then carried up to the groin of the same side and outwards round just below the top of the haunch-bone to the back, across the back to the opposite side, and then obliquely downwards in front to the top of the thigh where the bandage began. It is passed round the outer side of that thigh and across the back of it, and is brought up between the legs, and again taken in a sloping direction up the groin, to pass round the back as before. Each turn only partially overlaps its neighbour on its lower side. Care must be taken that the first turn is not carried so high up as to slip off the haunch-bones on to the abdomen. A double spica will cover both groins. For this a very long bandage would be necessary, and when it reached the side of the body opposite to where it started it would be carried down the groin on that side to the inner side of the thigh of the same side of the body, round the back of the thigh, and then up across the body to the side from which it started. The double spica is, however, seldom used.

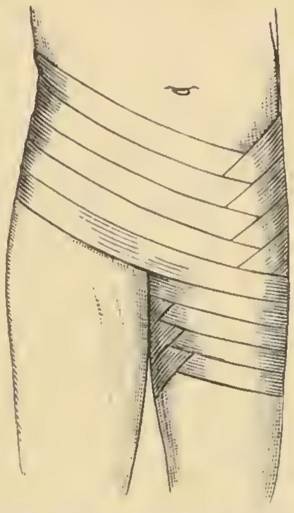


Fig. 346.—Spica of the Groin.

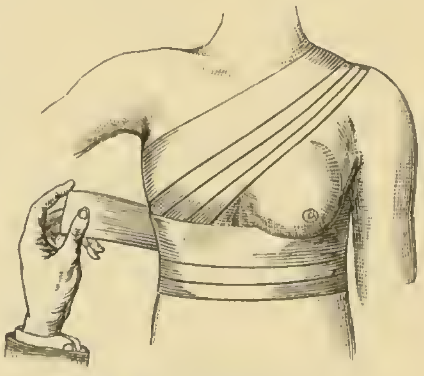


Fig. 347.—Bandage for the Breast.

To Bandage the Breast use a 3-inch roller. Begin in front and carry the bandage round the chest below the breasts, passing towards the *sound* side. Two or three turns are made to fix it, and then it is carried upwards in a sloping direction over the lower part of the breast to be covered to the shoulder of the opposite side, over which it is passed. It is then brought across the back to the arm-pit of the affected side, and is carried once round the chest to fix the upward turn by overlapping. When it comes to the front again it is carried upwards again, half overlapping on its upper side the previous upward turn, and passing over the shoulder is again brought to the front by the arm-pit, makes another complete horizontal turn round the chest, and then a third turn is taken over the shoulder. So the process is repeated till the whole breast is covered in (Fig. 347).

The Chest is bandaged by a series of spiral turns from below up; and the bandage is finally carried over the shoulders, like braces, to keep the whole from slipping.

The T Bandage (Fig. 348) is used for fixing dressings close up between the legs. Take a strip of calico 1½ yard long and 3 inches wide. It is used for encircling the body, and is represented by the horizontal part of the T. To the centre of it attach a similar strip 1 yard long, in the position of the leg of the T. The first portion is placed round the body and fastened in front, the other piece hanging behind is brought up between the legs, fixing the dressings, and is fixed to the front of the encircling band.

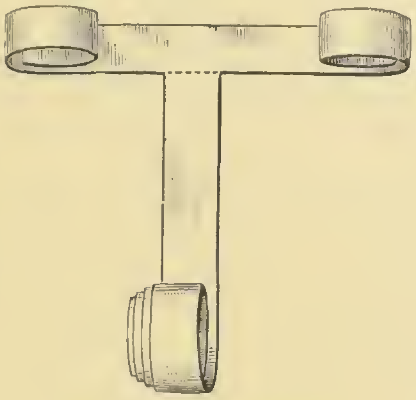


Fig. 348.—The T Bandage.

The Double T is shown in Fig. 349. The encircling band is the same as before. For the limb of the T a bandage double the width, or nearly so, is taken and torn up to within 5 inches of one end. This undivided piece is sewed behind to the band that passes round the body, and the two tails are carried up between the legs to the front. It acts like the previous bandage, but is more easily adjusted than the single tail.

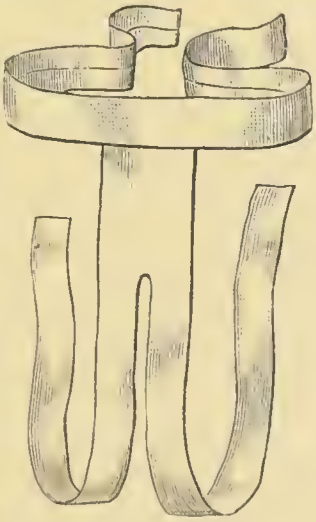


Fig. 349.—The Double T Bandage.

The Four-tailed Bandage is made with a piece of calico 1½ yard long and 6 inches wide. It is torn from each end up to within 3 inches of the centre. Thus there is a centre piece with four tails.

For the Chin this bandage is used by placing the middle of the centre piece on the point of the chin, and carrying the lower tails up the side of the head, tying them on the top, while the upper tails are carried backwards to a little above the nape of the neck and tied there. The ends of the two sets of tails are then tied together to prevent the upper ones from slipping forward on the head, and the lower downwards on the neck. This bandage may be used for the head by placing the centre piece on the top, tying the hinder ends under the chin, and the forward ones at the back of the neck.

The Many-tailed Bandage or Scultetus is shown in Fig. 350. It is used to apply to a limb when, owing to injury, it is extremely undesirable to disturb the limb by lifting, &c., to the extent that is necessary when the roller bandage is passed time after time round the limb. It may be made of an ordinary roller, which is cut into lengths sufficient to encircle the limb and leave 3 or 4 inches for overlapping. Thus, suppose it were wanted for the thigh. The measurement of the thigh at the knee, at the middle, and at the top would be taken. Then strips would be taken of those lengths, with an addition of 3 or 4 inches in each case. Other strips would be cut in lengths showing a gradual increase from the one near the knee to the one for the top of the thigh. Of such strips eighteen or more would be required. They are then arranged on a towel. Lay the strip that will encircle the *top* of the thigh down near one end of the towel. Lower down lay the next strip and make it cover the first to a third of its breadth; lay the next one in the same way to cover the lower border of the second, and so on till all the strips are in position one overlapping the other to the appropriate amount. A strip may then be placed right down the centre and fastened to each strip by a stitch, but this is not necessary. The towel may then be folded from one side to another and laid aside till required. When the bandage is to be applied the limb is gently raised, the towel, unfolded with the strips all in position, is slipped under it and properly placed. Then all that is necessary is to begin with the *lowest* strip, bring an end up on each side and overlap them, the ends of the second strip are similarly overlapped, and so on *up the limb;* and when the last strip is folded over and secured, one

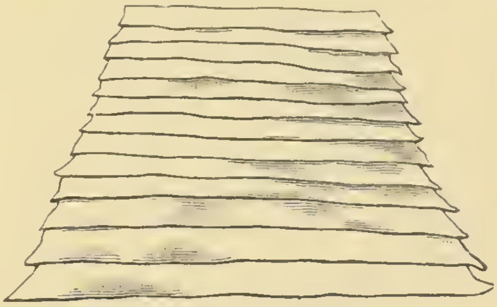


Fig. 350.—The Many-tailed Bandage.

ought not to be able to tell the difference between this bandage and one put on in the ordinary way.

Bandages for the Head.—There are several ways of bandaging the head according to the object in view.

The Capelline Bandage (Fig. 351) is used to secure dressings. It requires a two-headed roller, that is, a long bandage 12 yards long and 2 inches wide, rolled up from each end till the two rolls meet. The middle of the roller is laid against the forehead, and one end is passed round one side of the head, the other round the other side till they meet low down at the back. Here they are crossed. One end is then continued on its way round the head, the other end is carried up over the top of the head and down to the forehead. Here the roller travelling round the head passes over it to fix it down. It is then turned up and crossed over the head again, this time overlapping one side of the first turn over the head (Fig. 351), and when it reaches the back the travelling roller passes over it to fix it down again. For the third time it is brought over the head, this time overlapping the other side of the middle fold. So on the process is repeated, one roller being carried continuously round the head, the other passing backwards and forwards, now on one side of the middle line, now on the other, till the whole head is covered as shown on Fig. 352.

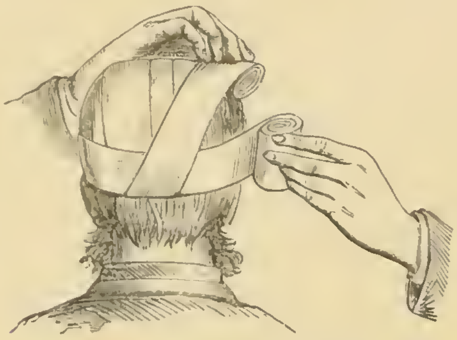


Fig. 351.—The Capelline Bandage.

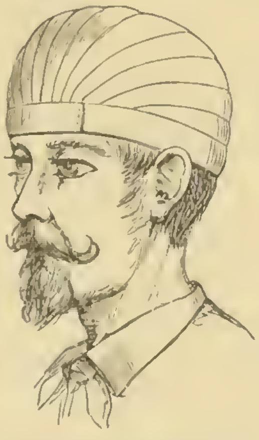


Fig. 352.—The Capelline Bandage Complete.

The Twisted or Knotted Head Bandage is employed when it is necessary to exert pressure on the artery at the temple to stop bleeding. A two-headed roller, 8 yards long, 2 inches wide, is used. The middle of the roller is laid on the injured temple, and under it is placed a cork inclosed in a double thickness of lint. One end of the bandage is carried round the front just above the eyebrows, the other backwards low down, till they meet at the opposite temple. Here they cross one another. When they meet over the injured part a twist is made exactly over the injury, and one end is carried under the chin, up the other side of the head, and on to the top of the head, where it crosses the other end which has been carried upwards. Both are carried on till they again meet over the injury, where a second twist is made, and the ends then carried round the head and fastened. One twist should exactly lie over the previous one. This may be done in a simpler way with an ordinary roller. Unroll about a foot of the bandage; hold it in one hand near the seat of injury, carry the roller round the head, and when it comes back to the wound give a firm twist with the loose end; then carry the roller under the chin, up the opposite side and over the top of the head, and when the wound is reached repeat the twist. Finally, carry the roller horizontally round the head again, and fix it by knotting the two ends. (See Fig. 353.)

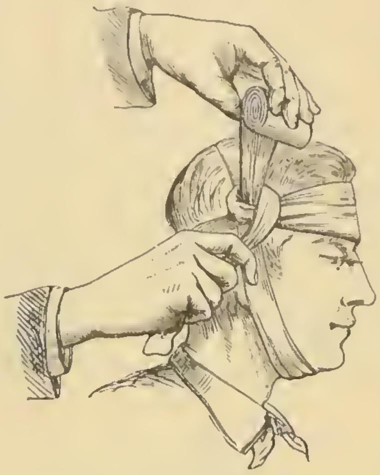


Fig. 353.—Twisted Bandage for Head.

A Simple Bandage to keep a dressing in position on the head needs only an ordinary roller. It is carried horizontally round the head above the eyebrows and low down behind, and, when it is once round, the turn is fastened by a pin. The bandage is then passed obliquely over the head across the dressing, and when it gets down to the horizontal turn it is passed once completely round, thus fixing the oblique portion. A second oblique turn is now made over the head, overlapping the former, and so on. A still simpler method, however, is to use the triangular bandage or a folded handkerchief to make the shawl cap.

The Shawl Cap is a very light bandage for retaining dressings. Fold a handkerchief into a triangular shape, as a shawl is commonly folded. Let the straight edge be applied to the forehead above the eyebrows, and the point lie over the back of the head. Carry the two ends to the back, cross them over the point, and then bring them round to the front and tie them there. Then turn the point up over the crossed ends and fix it with a pin. (See figures in Plate XV.)

Starch Bandages are roller bandages of loose texture, such as crinoline cloth or muslin, which are loaded with a thick starch paste, just before being applied. A thick paste of boiled starch is made, and while it is still hot the roller bandage is unrolled and passed through it, being loosely rolled up as it becomes charged with the starch. Before applying such a bandage to any part of the body, an ordinary roller ought to be put on, and any projecting parts protected with cotton-wool. Then, when the starch bandage is being applied, additional stiffness is secured by rubbing over the turns some of the starch paste. When the whole is complete it is covered in by an ordinary roller. The person on whom the bandage has been put must maintain the position of the bandaged part undisturbed for many hours, to allow the bandage to harden without change. Indeed it is a day or two before such a bandage would be sufficiently hard to enable movement to be made without risk of disturbance. This is the disadvantage of the starch, and herein lies the superiority of the plaster of Paris bandage. Such a bandage might be employed to put up a fractured limb, to keep joints at rest, and to exert continuous pressure over swollen parts.

The Plaster of Paris Bandage is much more useful than the starch bandage. Well-dried plaster of Paris is used. If the plaster has been kept in badly-closed tins, so that it has become damp, it may be dried in an oven with a heat not exceeding 200° or 260° Fahr.; a greater heat would destroy its setting power. A muslin or crinoline cloth roller of coarse open texture is used. As it is gradually unrolled on a table, the dry plaster of Paris is rubbed into it by one person, while another rolls it up loosely, keeping plenty of the powder between the turns. The limb or part of the body to be encased is meanwhile covered in by an ordinary roller, or by a flannel bandage, cotton-wool being placed over any parts requiring protection, and in the case of the foot between the toes. A minute or so before it is to be used, the loaded roller is placed on end in a vessel of water. There should be sufficient water to cover it. It is then applied to the limb or part prepared for it, in the case of a limb being begun at the extremity. The application must be made quickly, the plaster sets so quickly, but at the same time it should be uniform and neat. It is usual to increase the stiffening by making a thick cream with plaster and water, with which the turns of the bandage are smeared as they are rolled round the limb. Usually a couple of bandages 6 yards long are sufficient to produce the requisite degree of stiffness. After the plaster bandages have been applied, a dry roller is put on; the patient remains still, and within half an hour the whole bandage is quite firm. In the case of the leg, the person would be kept still, however, for several hours before movement was permitted, in order to secure perfect hardness and dryness of the plaster. Such bandages are quite commonly applied for fractured limbs, if they can be put on quickly after the accident and before swelling begins. The great advantage of such a method is that within a short time after the application has been made the patient can be transported for any distance without risk of displacement of the ends of the broken bone. They are also very useful for joints which it is desired to keep at rest, in order to permit of the removal of swelling, dropsy, &c. For instance, in the case of swelling of the knee-joint as the result of inflammation or sprain, &c., it is often possible by the use of a plaster bandage to permit the person to go about who, but for the support of the bandage, would be confined to bed or a couch. The employment of this bandage for spinal disease has been illustrated on p. 28.

The Triangular Bandage is of all others the bandage made use of for rendering temporary aid in cases of accident, and is the bandage now familiar almost to everyone, through the training in "First Aid to the Injured" afforded by ambulance associations. It was introduced by the distinguished German surgeon Professor Esmarch, as a means of applying a first dressing on the battle-field. Esmarch's bandages, and the bandages supplied by ambulance associations, usually have stamped upon them illustrations of the various uses to which they may be put in securing splints and dressings, in applying pressure to prevent bleeding, in acting as slings to give support to injured arms, and so on. The bandage is made of a square yard of calico or linen halved. Each of the two halves is a triangular bandage, having, of course, two sides 36 inches in length, meeting at the point of the triangle,

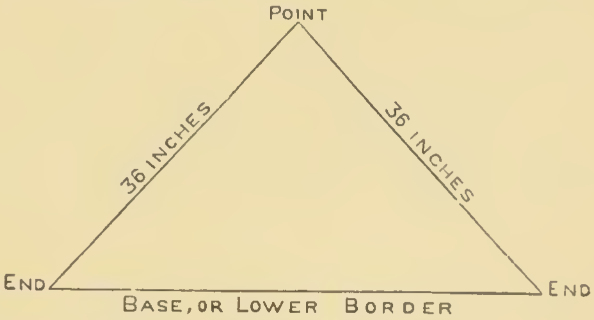


Fig. 354.—The Triangular Bandage.

and a base considerably longer, fully 50 inches (Fig. 354). The application of this bandage for the securing of temporary splints in cases of fracture is described in the third section, and its use for controlling bleeding from injuries is illustrated in the next section; but a few of its other uses will be pointed out here.

The Triangular Bandage as a Sling is illustrated in Plate XV. The bandage is laid, unfolded, across the body, one end passing over the shoulder opposite to the injured arm, the other end hanging down, and the point projecting out beyond the elbow of the injured arm. The arm to be bandaged is bent at the elbow, and carried over the chest, the hand being held higher than the elbow. The hanging end of the bandage is now brought up over the forearm and round the root of the neck on the same side, being tied with the end which passed over the opposite shoulder. The point is then brought neatly round the elbow and secured with a pin in front. (See Plate XV.) Such a bandage, when properly applied, carries the weight of the arm and relieves the shoulder. Sometimes only the hand and wrist are supported, the weight about the elbow being unsupported, as in cases of broken upper arm-bone, when the weight is needed to keep the upper arm on the stretch and prevent the broken ends of bone from riding on one another. In such a case the **small arm sling** is applied. ·(See Plate XV.) This is done by folding the bandage into a cravat-form, by folding the point down to the base and folding again so that a proper breadth is secured. The two ends are then passed round the two sides of the neck and secured as shown in the plate.

The Triangular Bandage for the Hand.—Spread out the bandage fully; lay the hand flat upon it palm downwards, the wrist resting on the base or lower border, the fingers directed to the point. Bring the point of the bandage over the fingers and back of the hand and let it pass over the wrist up the back of the forearm. Bring the two ends round the wrist, securing the point, cross them and carry them round to the front of the wrist, cross them again, bringing them to the back of the wrist, and tie them there. The point may be folded down over the crossing of the ends, on to the back of the hand, and fixed there with a safety-pin. The hand bandaged is shown in Plate XV.

The Triangular Bandage for the Arm.—Fold the triangular bandage into a broad bandage by folding the point down to the base or lower border, and then folding into two. Place the centre of this over the part to be covered, carry the ends round the arm, cross them, and carry them back again; let them be crossed again and carried round once more to the opposite side, where they are tied.

The Triangular Bandage for the Elbow.—Lay the centre of the bandage over the back of the elbow-joint, its lower border or base crossing the back of the forearm, its point passing up the back of the upper arm. Take the ends round in front, cross them, carry them to the back above the joint, and tie them there. Then fold down the point over the ends and secure it with a pin.

The Triangular Bandage for the Shoulder.—Spread the bandage out over the injured shoulder, its centre over the point of the shoulder, its point passing up the neck, its base or lower border resting over the middle of the upper arm. Pass the ends round the arm, cross them, bring them to the front and tie them there. Take a second triangular bandage, fold it into the small arm sling, and with it support the forearm. Let this sling pass over the part of the shoulder bandage that reaches up to the neck. Fold down the point of the shoulder bandage over the sling, and secure it with a safety-pin. This arrangement is shown in Plate XV.

Another way of bandaging the shoulder, when it is unnecessary to support the forearm, is to fold a second triangular bandage into a narrow bandage and carry it over the injured shoulder across the body and under the opposite arm-pit, the ends being pinned at the back and the front. The point of the shoulder bandage is then folded over this and pinned as in the former case.

A *single* triangular bandage may also be used to secure dressings, hot fomentations, poultices on an injured shoulder, in the following way. Let the centre of the fully unfolded bandage be placed over the shoulder as before, its point passing up the neck; carry the ends round the arm to the arm-pit, cross them there, and then take one end up in front of the shoulder, another up behind, and tie them, or pin them, over the top of the shoulder, then fold down the point over the ends and fasten it.

The Triangular Bandage for the Chest.—Spread the bandage out over the injured side, with its centre over that side; carry the point over the shoulder of that side, carry the two ends round the waist, knotting them there, one end being left long. To this end tie the point which has passed over the shoulder (Figs. 355, 356). The knots should be so placed to one side that they are not pressed upon when the patient lies down.

The Triangular Bandage for the Back is applied similarly to that for the chest, only the bandage is spread out over the back, the point passing over one shoulder and the ends round the waist to be knotted in front. This is an excellent method of fastening on poultices, dressings, &c. Where knots are undesirable the ends should be secured by safety-pins.

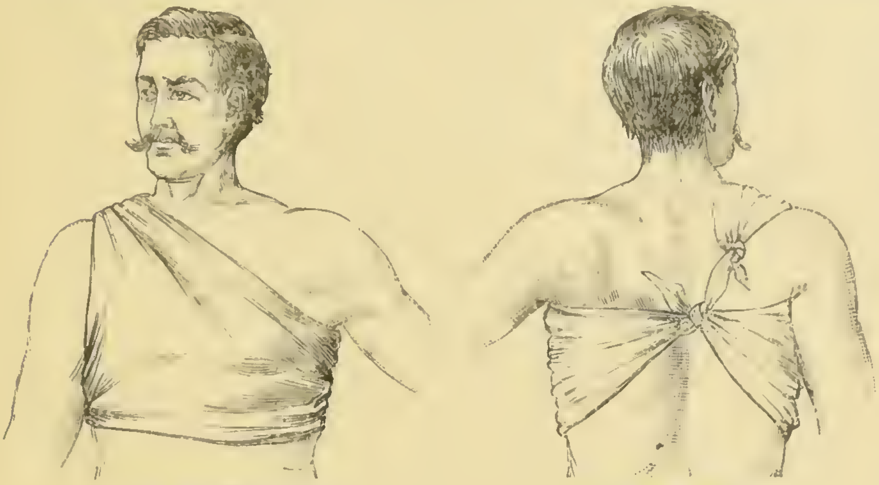


Fig. 355.—Front View. Fig. 356.—Back View

The Triangular Bandage applied to the Chest.

The Triangular Bandage for the Foot.—Spread out the bandage and lay the foot flat on it so that the end of the big toe is about the centre, the toes directed towards the point. Fold the point down over the toes and back of the foot, letting it pass up the front of the ankle. Bring the ends over the back of the foot, cross them, carry them round to the back of the ankle, cross them there, and bring them round to the front of the ankle, where they are tied. The point may then be folded down over the ends.

The Triangular Bandage for the Knee is similar to that for the elbow. The centre of the bandage is placed over the joint, the point directed upwards. The ends are carried behind, crossed, brought round to the front and tied, and the point is folded down over the knot and pinned.

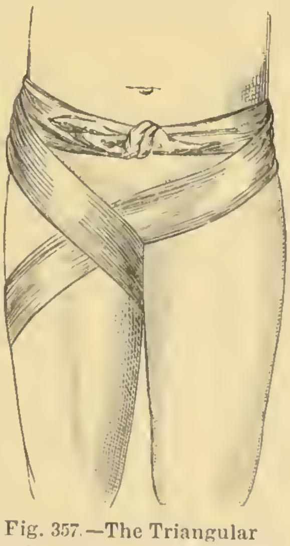


Fig. 357.—The Triangular Bandage applied to the Groin.

The Triangular Bandage applied to the Groin.—The triangular bandage may be used to fix dressings on the groin by folding it into a narrow bandage. To do this spread out the bandage, bring the point down to the middle of the base, then fold into three. Place the middle of this narrow bandage close up between the two legs, carry one end up in front along the groin, carry the other end up behind along the fold of the buttocks, cross them on the outside of the hip, and then carry the ends round the haunches, to tie them on the opposite side, or if the bandage be long enough continue the ends to the front and tie them there (Fig. 357).

The buttocks require two triangular bandages. One is folded into a narrow bandage and tied right round the body as a belt, always low enough to be over the haunch-bones. A second bandage is spread out so that its point passes up on the outer side of the buttock to be covered. The point is passed up under the belt and then folded down over it, to be pinned there. The middle of the base or lower border of the bandage should reach down below the lower edge of the fold of the buttocks. The ends are carried round, one over the front of the thigh, the other behind, and are tied or pinned (Fig. 358).

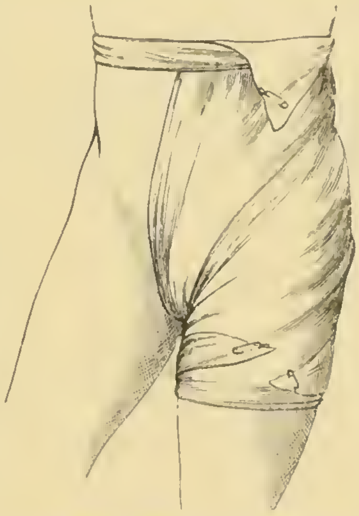


Fig. 358.—Triangular Bandage applied to the Buttocks.

The Triangular Bandage for the Head is applied in the form of the shawl cap, as described on p. 960, and illustrated in Plate XV.

The Knotting of Bandages.—The knot which is commonly made is familiarly called the **granny knot.** The direction which the ends take is shown in Fig. 359, and the appearance of the knot when drawn tight on a bandage is illustrated in Fig. 360; the ends

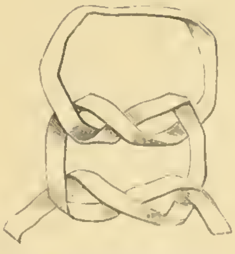


Fig. 359.—Granny Knot.

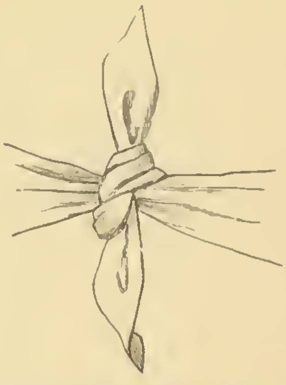


Fig. 360.—Granny Knot tight.

set *across* the direction of the bandage. This knot should never be used for surgical purposes. The thread, tape, or bandage so tied is seldom secure, and always liable to slip. It is in surgery usually of the utmost consequence that the possibility of slipping should be entirely discounted, especially when the firmness of dressings over a wound or the stoppage of bleeding is dependent upon the knot being secure. In all such cases the **reef-knot** should be employed (Fig. 361). It will be noticed that in both cases the first turn is the same. When this has been made, if the loose end opposite the person's right hand be carried across and held in the left hand while the other end is taken first *under* it and then over it, the ends will be in the position shown in Fig. 361. In the case of the granny knot the second end is taken *over* the first and then under it. When the ends of a bandage are tied in a reef-knot, and the knot pulled tight, the appearance of the knot is as shown in Fig. 362; the ends set *in line with* the direction of the bandage.

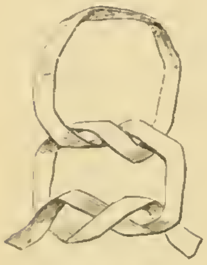


Fig. 361.—Reef-knot.

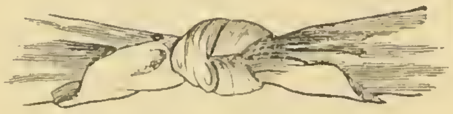


Fig. 362.—Reef-knot tight.

The **clove-hitch** is used for fastening a bandage or towel round a limb in order to give good hold for a firm pull. Fig 363 shows how it is made. The bandage is caused to make two turns or bends on itself, as shown. The second bend, that to the right in the figure, is then placed behind the first, and through the space formed by the opposite halves of the two, and marked + in the figure, the limb is placed. Fig. 364 shows the hand passed through and the ends of the clove-hitch hanging from the wrist. The two ends, being taken hold of, afford an excellent means by which the arm may be strongly pulled on. The more strongly one pulls the tighter does the noose become, and there is no possibility of it slipping, while it may be unloosed, if needful, in a moment. In a case of dislocation at the shoulder-joint, for example, the clove-hitch would be applied round above the elbow-joint, and thus the lower end of the dislocated bone would be directly pulled on in the effort to reduce the displacement.

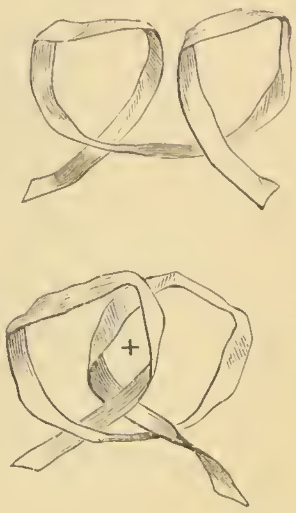


Fig. 363.—Clove-hitch.

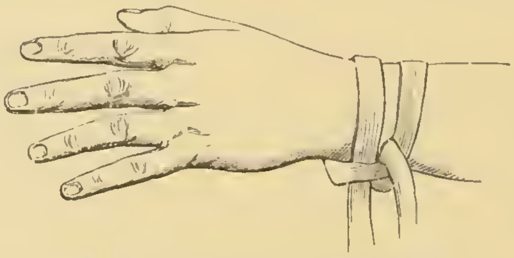


Fig. 364.—Clove-hitch applied to Wrist.

Section II.

THE TREATMENT OF WOUNDS AND BRUISES. THE ARREST OF BLEEDING. POISONED WOUNDS, SNAKE BITES, AND INSECT STINGS.

Wounds and Bruises and their Treatment.

- Varieties of Wounds:
  - *Incised, Punctured, Lacerated, and Contused Wounds.*
- The Repair of Wounds:
  - *Healing by Immediate Union;*
  - *Healing by First Intention*—Scar or Cicatrix;
  - *Healing by Second Intention or Granulation*—Healthy Pus.
- The General Treatment of Wounds:
  - *The Stoppage of Bleeding;*
  - *Cleaning the Wound;*
  - *The Closing of the Wound*—The Use of Strapping and Sutures;
  - *The Protection of the Wound*—Dressings and Bandaging.
- The Re-dressing of Wounds.
- The Treatment of Incised or Clean-cut Wounds.
- The Treatment of Punctured, Bruised, and Lacerated Wounds.
- The Treatment of Wounds of the Scalp.
- The Treatment of Bruises or Contusions—Ecchymosis—How to Treat a Black Eye.

The Arrest of Bleeding.

- The Distinction between Bleeding from an Artery, a Vein, and Capillary Vessels.
- The Methods of Stopping Bleeding:
  - *Elevation of the Wounded Part;*
  - *The Application of Cold and Astringent Substances*—Styptics;
  - *The Application of Pressure;*
  - *To Arrest Capillary Bleeding;*
  - *To Arrest Bleeding from a Vein;*
  - *To Arrest Arterial Bleeding*—Methods of arresting bleeding from the arm and hand, foot and leg, head and neck, nose;
  - *Tourniquets* and how to apply them to stop bleeding;
  - *Artery Pressure or Catch Forceps.*

Poisoned Wounds; Insect Stings; Snake Bites; and other Kinds of Poisoned Wounds.

- Poisoned Wounds and their Treatment.
- Stings and Bites of Insects and other Animals:
  - *Bees' and Wasps' Sting and its Treatment;*
  - *The Mosquito Bite;*
  - *The Chigoe or Jigger;*
  - *Ticks; Bed-bugs; Spiders*—The Tarantula;
  - *The Scorpion and Centipede;*
  - *The Guinea-worm.*
- Snake Bites:
  - *Non-poisonous Snakes*—The Common Snake, the Black Snake, the Anaconda, Pythons, and Boa.
  - *Venomous Snakes*—The Viper and Rattlesnake, the Water Viper or Moccasin, the Copper-head and Cotton-mouth, the Harlequin-snake, the Jararaca, the Tiger-snake and Death Adder, the Horned Snake and Puff Adder, the Asp, the Cobra, Bungarus, Russell's Viper and Ophiophagus Elaps.
  - *The Treatment of Snake-bite.*
- The Poison of Venereal Disease:
  - *Gonorrhœa, Bubo, &c.*

WOUNDS AND BRUISES AND THEIR TREATMENT.

Varieties of Wounds.—Wounds are commonly divided into four classes: (1) **incised wounds**, inflicted by sharp instruments, so that the wound is clean cut; (2) **punctured wounds**, wounds caused by narrow instruments being forced into the body, including stabs, pricks,

&c.; (3) **lacerated wounds**, which are of the nature of tears; and (4) **contused wounds**, which are caused by falls or blunt instruments, and in which the parts about the wound are bruised. These distinctions are of importance even from a popular point of view. There are, comparatively speaking, few people who are unfortunate enough to get a bone broken, but almost no one, if any one, escapes a wound of one kind or another. Everyone ought to know, in a general way, how to treat the ordinary kind of wound, of which every household has more or less experience, and a knowledge of the distinctions between the different kinds of wounds enables one to perceive very easily the appropriate means of dealing with each as it arises. In the simple clean-cut wound, for example, there is practically no destruction, no death of parts. Supposing the instrument to have been clean and the wound clean, setting aside for the moment the question of bleeding, there is little needed, it is plain, but the accurate bringing together of the divided parts to secure the closure and healing of the wound. On the other hand, in the case of the contused wounds, or wounds accompanied by bruising, there is destruction more or less severe and more or less extensive of some of the wounded tissue. The vitality of the parts has been lowered, their power of repair seriously diminished, and of some portions of them completely abolished. It is evident that the attempt to close such a wound, as one would a clean-cut wound, is doomed to failure, for the parts that have been destroyed, however small, must come away before healing can occur. When the bruising has not been severe enough actually to destroy any of the tissue, it may be that by appropriate methods, by careful nursing of the wound, so to speak, the diminished vitality may gradually be restored to full activity and all the tissue saved. But to adopt the methods proper for keeping close together the cut surfaces of the clean-cut wound might be to ensure the death of the parts in a bruised wound. A torn wound is in something of the same position. If the parts have not been pressed upon, as in the bruise, they have been violently torn apart, and the strain upon the tissue must have seriously lowered its vitality and power of repair. Then the punctured wound will partake more or less of the character of the clean-cut wound, if it has been inflicted by a sharp-pointed and sharp-edged instrument, or of a bruised wound if the instrument has been blunt-pointed, or, while sharp in the point, is thick and blunt beyond it, as, for example, a steel for sharpening knives; or the punctured wound may be also of the nature of a tear. But one special point to be remembered about it, whatever its character, is that it is deep out of all proportion to the extent of wound shown on the surface, that if the instrument were dirty, some of the dirt may be lodged in the depth of the wound, beyond the reach of sight, or some fragment of clothing or other material may have been carried in with the point of the instrument, or, for that matter, some portion of the instrument which did the damage may have broken off in the depth of the wound and be lying there.

Now many people who read these sentences will be inclined to say, "Oh, well, really, these are fine points for a surgeon to consider, which the ordinary man or woman cannot be expected to take into account." But this is not, in any sense, true. They are most important points, but they are not "fine points" nor "difficult points." They need the exercise of nothing more, or little more, than ordinary common sense. So long as cut fingers, and broken knees, and bumped heads are the common incidents of a household—so long as wounds and bruises are the everyday occurrences of a workshop—so long as every mother thinks that she is quite fit to attend to the ordinary run of these things herself, and every workman that he can "doctor" any ordinary small affair himself, so long should every man and woman think it necessary to look at the simple common sense of the matter, and be ready to apply it when necessary. Therefore let us look for a minute at the two ways of regarding even the minor wounds and accidents which everyone thinks he can treat "just as well as the doctor." The one way is to regard its mere size, and if it does not look big, and there is nothing terrifying in its aspect, and no bleeding worth talking about, to cover it up with a rag or stick a piece of plaster on it, and expect it to heal without further trouble. And of course, in nine cases out of ten they do heal, because nature is fit for the most of the demands made upon her reparative powers. But perhaps the tenth case goes wrong, and, as likely as not, the injury seemed at first of the most trivial kind. Nevertheless, owing to the want of observing a little common sense, and after many days, the doctor is, perforce, appealed to, because the slight cut, or the small bruise, or the prick that was hardly worth talking of, has become a large, deep, foul sore, which refuses to heal, and gives much pain and general disturbance. Now what we have called the common-sense way of looking at even a trifling injury is followed, when the person asks himself the question, What kind of a wound is it? is it a clean-cut wound which should heal easily, or is there much damage to the parts which may cause it to heal with greater difficulty? secondly, when the person asks the question, What did it? the answer to which will probably indicate whether any foreign material has been carried into the wound, likely to lead to an interference with its quick healing; and thirdly, when the person gets, if possible, the object which caused the wound, still further to settle the second point, and to make certain that, if it was material likely to break, no part has been left in the wound. It does not need much, if any, special skill to determine these points, and when they are determined anyone will be in the position to decide with tolerable accuracy whether the wound is as trifling as it looks, and whether simple and unskilled treatment will be sufficient. For it must never be forgotten that the smallest possible wound may occasion the greatest possible trouble, if by it there gain entrance to the body any foul or putrefying material capable of propagating itself in the tissues, and that tissues of lower vitality, and consequently diminished resisting power, will offer to it a most suitable lodgment.

If, then, one remembers the four different kinds of wounds, little difficulty will be experienced in deciding, regarding the ordinary run of simple injuries, which of them are the more serious, and what are the special things to be attended to in dealing with them.

The Repair of Wounds.—The clean-cut wounds show the simplest and most rapid method of repair when they heal by what is called immediate union. In this case the surfaces of the wound are brought accurately together throughout their whole extent; they adhere closely, and after the lapse of a few days they have become reunited, and are continuous, the circulation being completely re-established, *no scar being left* to indicate where the wound was. This is a mode of healing that does not very often occur, and can take place only under the most favourable circumstances. It is evident that it cannot occur unless every portion of the divided parts, and not the *edges* of the wound only, are accurately and firmly replaced in their original situation. This cannot be done if streaks and clots of blood are allowed to remain in the wound, or if bleeding goes on after the wound has been closed, or if particles of dirt are left in it; nor can it occur if matter forms; nor is it at all likely to take place if any time has elapsed since the wound was produced, so that the two surfaces of the wound have become coated with a film of coagulated material. In all other methods of repair new material is formed to fill up the breach which the wound has caused. This new material is not produced from the blood clot which may fill the wound. It seems to be produced from two sources. In describing the structure of the blood, on p. 213, the white cells of the blood, or white blood corpuscles, or leucocytes, have been spoken of, and it has been explained on p. 214 how these cells are capable of passing through the walls of the fine blood-vessels and wandering through the tissues. Now if a small piece of the material which is filling up a healing wound be examined under the microscope it is found to consist of a mass of such white cells, and the belief is that soon after the wound has been produced white cells from the neighbouring vessels find their way to the seat of injury, and there multiply in enormous numbers, affording thus the material for repair. This is not a mere fancy nor bit of imagination; the process can be witnessed going on under the microscope. The passing of the white blood corpuscles from the fine capillary vessels may be watched in the web of a frog's foot, viewed under the microscope, if the surface of the web be irritated in some way. The appearance under the microscope is shown in Fig. 365. Every tissue, skin, muscle, nerve, bone, &c., contains a certain amount of connective tissue (see p. 16). One of the elements of connective tissue is cells, which, in the opinion of some, are capable of

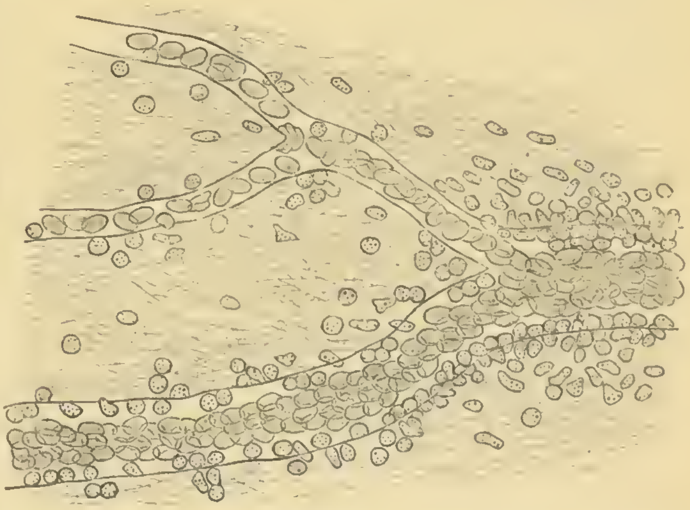


Fig. 365.—The appearance under the microscope of a minute piece of fine tissue which has been irritated. A blood-vessel is shown branching. The red corpuscles are seen streaming down the centre of the vessel, the white corpuscles are rolling along the walls of the vessel, adhering to them, and passing out of the vessel in great numbers, and finding their way in the direction of the seat of injury.

multiplication, so that some of the new growth formed to fill up a wound may be derived from the cells of the connective tissue of the part. Suppose then a clean-cut wound, and the edges brought together. The two cut surfaces are not absolutely united, a fine probe could readily be insinuated between them, just after they have been brought together. But in twenty-four hours this is no longer so, the fine gap is filled up and the edges of the wound are glued together. Of course a little violence would still separate them; but the difference between the state of the wound now and its condition twenty-four hours before is marked. What is the cause of this? The gap is filled up by cells held together by material which has oozed from the blood-vessels, of a fibrinous nature, which "sets," so to speak, and thus glues both sides of the wound together with the cells into one closely coherent mass. The cells undergo rapid change of form; from round cells they become spindle-shaped, and in the course of a few more days the wound is united by a wedge of new tissue of a fibrous character, which condenses and becomes firmer, and into which an extension of blood-vessels takes place from surrounding parts, so that by and by the position of the wound is only indicated by a fine white line, or scar, or **cicatrix**, the edge of the new slice of tissue which nature has introduced to unite the separated surfaces. A wound which unites in this way is said to heal "**by first intention.**" This is the kind of union one seeks to bring about; there is no loss of substance, no matter is produced, and there is no interruption to the healing process. For such union it is necessary that there be no blood left in the wound, or dirt of any kind, since either would interfere with the healing process by leading to the formation of matter which would require to be expelled. Then healing by first intention cannot occur in a wound accompanied to any extent by bruising, for particles of the tissue are in such a case destroyed, and will be sooner or later separated from the living healthy tissue.

In wounds where there is any loss of substance, any destruction of particles of the tissue, healing takes place by what is called **granulation**, or by **second intention**. In the case of a wound on the surface, say a bruised wound, there is a discharge from the surface, a thin yellowish-red discharge, consisting partly of fluid oozing from the wound and partly of the dead particles of tissue. In the course of a few days the wound has become an open sore, with a more or less even surface considerably below the level of the skin. After all particles of dead tissue have been removed the surface of the wound should be uniformly clean and red. If it be carefully examined it will be seen that the surface is not glazed and smooth, but is covered all over with fine red granules projecting from the surface. These are called **granulations.** They are formed by masses of the round cells already spoken of, and fine loops of blood-vessels project up from the sound tissue below into the granulations. They are, in a healthy wound, fairly firm, but any rough handling will make them bleed. They grow rapidly, coalescing with their neighbours, and as this goes on the wound gradually becomes shallower, gets filled up, and approaches the level of the surface. The material thus formed is really the same as that which united the opposed surfaces of the closed wound. During this process matter is continually being separated from the surface, of a creamy thickness and pure yellow, and without smell, if the wound has been kept clean. This matter is called **pus**, healthy pus, and if it be examined under the microscope it is seen to consist of round cells; in fact of cells similar to the wandering cells spoken of, and which come from rapidly-multiplying cells of the granulations. When the gap caused by the wound has been filled up and the granulations reach the level of the skin, the surrounding skin begins to advance inwards. A pink border surrounding the wound indicates the activity of the circulation going on to aid growth, the pink border thinning away towards the wound. Day by day the size of the wound is seen to be lessened, until it is wholly covered by a scar, formation of matter having ceased. In the deep parts of the new tissue condensing changes occur, which also extend to the surface, and this shrinkage goes on for a prolonged period till the size of the scar or cicatrix is ultimately very much smaller than that of the original wound.

When the granulations receive too great a supply of blood, they become excessively large and flabby, and soft, not firm as they should be. They are said to be exuberant. In such circumstances they sprout beyond the level of the skin, and are popularly called "proud flesh." It is common to reduce them by the use of caustic. This is a mistake. Firm pressure with a pad and bandage will usually restrain them sufficiently to enable healing to go on to a satisfactory termination.

When healing takes place under a scab it very much resembles that which occurs in the healing by first intention. But, owing to the presence of irritating material, matter may form under the scab, and its confinement might lead to extensive destruction of parts and the production of a deep sore. This, however, would be indicated by pain, inflammation, and a soft boggy feeling of the part. When, however, the wound and its scab are firm and dry, and there is little redness or tenderness, one may be assured that the healing process is going on satisfactorily, and when the wound is finally closed the scab will become readily detached. The scab is, in short, nature's method of closing the wound to prevent the entrance of disturbing elements from the outside, and of protecting the part till the breach has been repaired.

Now it must not be supposed that it is only in exposed wounds, in wounds on the surface of the body, that such methods of repair are found. Injuries in the deep parts are repaired in precisely similar ways. Bone is repaired in a similar way: the new tissue, which in the skin takes on the resemblance to skin, in bone comes in time to resemble bone, knitting its broken ends firmly together. Muscle is repaired in a similar way, so also is nerve. If a divided nerve be accurately united the new tissue formed at the place of union will in time take on the form of nerve tissue, and the function of the nerve may be restored.

The General Treatment of Wounds.—It will be clear from what has been said that the treatment of wounds will vary to some extent with the nature of the wound. While that is so, there are certain general rules to be followed with any or every wound. Let us see first of all what these are, and then we can consider what changes are required to meet the different kinds of wounds. The rules are these:—

I. Stop bleeding.
II. Cleanse the wound and remove all dirt and other foreign material.
III. Restore the parts, as nearly as possible, to their proper positions, diminishing gaping as much as possible.
IV. Secure complete rest to the part, and protect it from outside influences, but take care to prevent the accumulation on or in the wound of any discharge.

I. As to the arrest of bleeding, the proper methods of doing so will be considered later in this section. A very large number of the ordinary wounds, however, give little trouble in this respect. It is only when an artery has been cut, or a vein of some size, that bleeding is troublesome enough to tax the resources of the layman. Raising the part, the use of cold water, pressing on the wound itself with a piece of clean lint, will usually be sufficient to stop the welling up of blood from the ordinary wound. One thing must not be done: cloth after cloth, handkerchief after handkerchief, must not be piled on the wound, and then the whole part enveloped in some ample dressing. If an artery or large vein has been wounded, it is highly improbable that the bleeding will thereby be made to cease. It will only continue, *without being seen*, till the whole mass of covering has been soaked through. No one must delude himself with the belief that bleeding is stopped *because it is hid.* This is akin to the fatal policy of the ostrich, which hides its head in the sand, in the delusion that the hunter will not see it because it does not see him. Nor is it advisable to pour on the wound substances like friars' balsam, or steel drops, or other discolouring and sticky substances to arrest the bleeding. No attempt should be made to bring the surfaces of the wound together or to dress it till bleeding has ceased. Often when no large vessel is wounded there is a very considerable flow of blood from the fine capillary vessels, which does not readily stop. For this the use of an iodine lotion is recommended, 20 drops tincture of iodine in an ounce of warm water, or, roughly, as many drops of the tincture in a basin of warm water as will make the water of a light sherry colour. A sponge, or, preferably, a piece of clean lint wrung out of this lotion and pressed on the wound for a minute will usually be sufficient. It is besides a useful lotion for cleaning the wound.

II. The cleaning of the wound and the arrest of bleeding will often go together. Even though the cleansing of the wound starts the bleeding afresh for a little, it must be done, since to permit a mass of blood clot, dirt, &c., to remain in and around the wound is only to encourage decomposition and the production of a foul-smelling sore and to delay the healing process. But the cleaning process should not be roughly done. A gentle stream of water, tepid or cold, is caused to play on and about the wound; and gradually clots and foreign material will be washed away. Small pieces of surgeon's lint may be used, well wetted, gently to wipe the wound, and assist in the removal of clots, &c. The water should contain some antiseptic material, if it is at hand, such as carbolic acid, 1 ounce to 2 pints of water, or the iodine lotion already mentioned. When the wound and surrounding parts are thoroughly clean, it should be carefully examined to see that no foreign material lurks in its corners or is embedded somewhere in it. As already mentioned a knowledge of what caused the wound will help in determining whether any splinter of material is likely to be buried in it. If so, it must be searched for and removed, otherwise suppuration will ensue, and the wound will refuse to close till it has been removed.

III. The restoration of separated parts to their original position is easily accomplished in clean-cut wounds, and is the proper thing to do, since it promotes their speedy union. But in torn and bruised wounds accurate replacement is needless, since some of the tissue is certain to break down and be separated, either in pieces, which are called **sloughs**, or in the form of discharge. Still the chance of their reuniting should be taken advantage of, though not to the same extent as in the clean-cut wounds, and care must be taken to provide for the escape of any discharge or separated particles. The surfaces of the clean-cut wound are brought together either by strips of adhesive plaster, by sutures, or stitches. It must not be forgotten, however, that the edges, the surface, of the clean-cut wound may be brought together and the deep parts may gape. Fluid and blood may, therefore, ooze between the deep parts of the wound, separating them farther, while the external edges are uniting. Thus a collection of matter may form in the depth of the wound, bursting open the united edges sooner or later, and causing pain and swelling before that occurs. In every clean-cut wound of any depth, therefore, surgeons as a rule try to unite the divided surfaces by the passing of sutures or stitches from one side of the wound, through its depth, to the other side, and further aid in keeping the parts together by carefully-adjusted pads at a little distance from each side of the wound. In shallow wounds strips of plaster may do all that is necessary. But in exposed parts, where it is desirable to have as little scar as possible, as on the face, even shallow wounds are stitched together. The sutures are usually of silver wire, or of catgut or silkworm gut, usually soaked in carbolized oil, appropriate needles being employed. In shallow wounds black silk thread, well waxed with bees'-wax, introduced by fine sewing needles—No. 9—suit excellently. The use of carbolized catgut or silkworm gut is now very extensive in surgery, because it does not require removal after the wound has healed. The part buried in the tissues becomes gradually softened and absorbed, and the external ends then drop away. The ordinary adhesive strapping, or lead plaster, is in common use for closing a clean-cut wound. It should be cut in strips of about a quarter of an inch in breadth and of sufficient length to extend a considerable distance on each side of the wound in order to have a sufficient surface of support. The plaster is warmed all over its surface by heating before a fire or over a gas flame, and is fixed on one side of the wound. Then while the finger and thumb of the left hand keep the edges of the wound accurately together, the right hand carries the strip over to the other side. The plaster is smoothed down close over the skin and held for a few seconds till it has secured a firm hold. If the wound or skin be wet, the plaster will of course not adhere at all. A method of applying the strips to avoid "cockling" is shown in Fig. 366. Two strips are used, cut as shown in the figure; one is applied on one side of the wound, and the other on the other side. The end of one strip is then passed through the slit in the centre of the other, and then an even pull on both ends accurately closes the wound. The strapping should never completely cover the wound. Intervals should be left between each strip, and the corners of the wound should not be strapped, that an opening may be left for the escape of any oozed fluid.

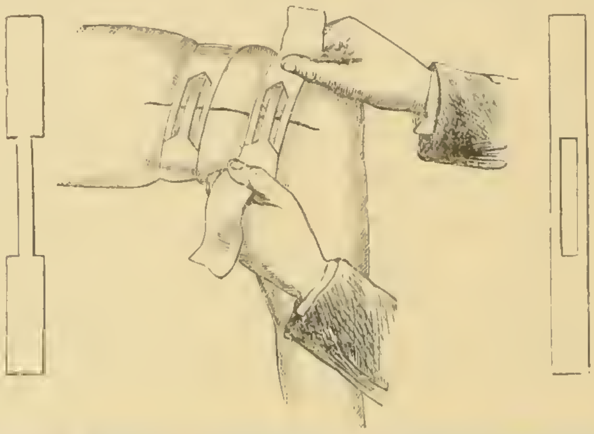


Fig. 366.—A Method of applying Strips of Plaster to close a Wound.

It has been said that it is undesirable to attempt to close bruised or lacerated wounds, since the death of some part of the tissue is almost certain. As a rule, that is to say, sutures or strapping are not employed to bring the separated surfaces together, though parts are replaced, after being cleansed, as nearly as possible in their proper positions. In the case of punctured wounds, however, the external opening of the wound is kept open, instead of its union being promoted, in order to ensure the escape of any discharge or oozing of blood, &c., from the depth of the wound. It is not till the lapse of a few days, when all risk has passed away, that the opening is allowed to close.

IV. The protection of the wound from disturbances of various kinds is one of the chief means of promoting its healing. One of the most important ways of securing this is by rest, complete rest of the part involved. Suppose a cut extends across the wrist, nothing could be more hurtful, or could more seriously delay healing, than the use of the hand in any occupation whatever. Many people think if the part has had some dressing applied and is bandaged, it should be sufficiently supported, and that they ought to be able to go about their ordinary duties. If it does not unite rapidly, and if it shows signs of inflammatory action along the edges, they are strongly disposed to blame the surgeon for not having applied the appropriate dressing, ignoring the fact that they are not giving the opportunity for natural recovery. If, therefore, any part of the hand or arm has been wounded, it should be carried in a sling. If the wound is near a joint, a splint will probably be applied to prevent motion of the joint. In every wound of the fingers, of any extent, this is a necessity. If the wound is on the foot or leg it is proper for the patient to rest in bed or on a couch for one or two days at anyrate.

Then the wound needs protection from irritation of its surface, from atmospheric influences, and for this purpose a dressing is applied. It is commonly supposed that some application should be placed on the wound to promote its healing, or something to "draw" out of it any inflammation that may arise. Hence the use by the public of all sorts of healing ointments, white zinc ointments, basilicon ointment, and so forth. It may be taken as a general rule that this is entirely erroneous. Such applications are entirely discarded by modern surgeons. If the person be in a good state of general health, the natural reparative powers of the body are perfectly sufficient for all healing purposes. The all-important point is to give nature a full opportunity for doing her own work by keeping the wound clean. The applications used now are almost entirely such as are designed to accomplish this purpose by preventing decomposition occurring at the site of the wound, which decomposition is set up by dirt in the wound or by particles deposited from the air, as explained in Section XIII. p. 384. Such applications are considered at length in Part III. Section IX. p. 910, and are called antiseptics. Antiseptic solutions are employed to wash the wound, and the commonest in use are the carbolic acid lotion, 1 part in 40 of water (p. 910), or the lotion of sulpho-carbolate of zinc (p. 911), or the lotion of boracic acid (p. 911), or permanganate of potash solution (p. 912), or a weak perchloride of mercury solution (1 in 5000, p. 912), or the iodine solution mentioned above. If the dressing is soaked in any material it should be one of these. But a perfectly dry dressing is the simplest. and is often to be preferred, and ought nearly always to be so in the case of clean-cut wounds. At the same time the dressing should be of such a nature, and should be so applied, that it will not cause any discharge to be retained, but will permit it to escape or will absorb it—lick it up. For such a purpose nothing is better than the absorbent wool or gauze now obtainable from every druggist. Such gauze is now obtainable impregnated with corrosive sublimate, or boracic acid, or eucalyptus, or other antiseptic. For domestic and popular use nothing could be better than this; a layer—dry—would simply be applied over the wound and would be secured by a roller or triangular bandage. An excellent oily application is made with 3 parts of olive-oil and 1 part of terebene. A piece of lint is soaked in this and placed over the wound and is then covered with a dry piece of lint or a layer of absorbent cotton, the whole being secured by a bandage. Simple water dressings are seldom desirable, since they promote decomposition, and the wound thus becomes foul-smelling.

It remains to be added that surgeons now always provide for the escape of discharge from a wound, and take care not to apply dressing in a way to prevent the escape of any matter that may form. In the case of deep wounds a piece of fine india-rubber tubing is passed into the wound, so that its one end is at the very bottom of the wound and the other end projecting. This provides an escape for any matter or fluid that would otherwise accumulate. As the wound heals from below, the tube is made shorter and shorter, till it may finally be removed altogether.

The Redressing of Wounds.—After a wound has once been properly cleansed and dressed it is well to leave it undisturbed for several days, undoing the dressing every day being only a cause of irritation, except in special cases. If the wound has been clean cut and is likely to heal readily, it should not be disturbed for four or even six days. If the parts, however, have been bruised or torn, earlier redressing will be necessary for the removal of matter and any separated parts of the tissue. Probably every second day will be sufficient, though more frequent redressing is necessary when there is much discharge. Each case, however, must be judged by itself, the rule being that so long as the part is comfortable, and pain, or heat, or throbbing is not arising, it may be left alone. When the wound has been stitched, a few of the stitches are removed on the third day, others perhaps a day later, and so on. In undoing the dressing, no roughness should be allowed. If the dressing adheres, it is to be softened by a stream of water, carbolized or iodine water, and the lint or cotton soaked till it slips off of itself. A fresh dressing should be already prepared, and after the wound has been well bathed with the antiseptic solution, reapplied.

Subject to the above explanations regarding the general treatment of wounds, we may now give brief directions for the treatment of each of the varieties of wounds mentioned.

The Treatment of Incised or Clean-cut Wounds.—Having stopped the bleeding by raising the part, by using cold water, by firm pressure for a minute or two with a small piece of dry lint, or lint soaked in cold water, or in water tinged to a light sherry colour with tincture of iodine, or by some of the other methods noted in detail on subsequent pages for cases of serious bleeding, the person must proceed thoroughly to clean out the wound, removing all clots of blood, all dirt, fragments of hair, or other foreign matter. This is to be done by a gentle stream of cold water, or carbolic acid lotion, or the iodine water already spoken of. The cut surfaces must then be brought carefully and accurately together and held so by strips of adhesive plaster, stitches being preferable if anyone competent to insert them be present. A dry piece of lint or absorbent cotton, or lint soaked in the oil and terebene mixture (p. 971), is laid over it, then another larger piece placed above it, and the whole secured with a roller or triangular bandage. If the wound be on the arm or hand, the limb is secured by a broad sling (p. 962). In the case of a finger or a wound near a joint a splint should be applied. A piece of thick cardboard, cut of a suitable size, covered with a layer of absorbent cotton, will suit, and it is secured by the bandage. The patient should rest if the wound is at all severe. Redressing is not to done for four or six days, and subsequently every second or third day if needful. In the event of much pain, swelling, &c., arising, it may be advisable to remove the dressings, and if the wound seems much inflamed, cold or iced water cloths should be applied for ten minutes or so at a time at intervals of an hour or two till the pain and swelling are relieved. If the bulging of the wound seems to indicate any fluid retained within it, a strip of plaster should be removed to permit of its escape. The gentle insertion of a fine probe at one corner of the wound will permit of the escape of such fluid; a blunt-pointed knitting-needle, previously cleaned by being dipped in boiling water, would suit. The dressings would then be reapplied *lightly*.

The Treatment of Punctured Wounds.—These wounds are to be treated as detailed above for clean-cut wounds, with one notable exception—*the lips of the wound must not be closed, but kept open.* It is so difficult to ensure the thorough cleansing of such a wound that provision must be made for the escape of fluid or matter from the bottom of the wound. The lips of the wound are, therefore, to be kept *slightly* apart by the insertion of a very small piece of absorbent cotton or lint. If in two or three days there is no sign of any fluid, the wound is then allowed to close.

The Treatment of Bruised and Lacerated Wounds.—In these cases bleeding being arrested, and in such cases bleeding is comparatively slight, the wound must be very effectively cleansed. If this is necessary in clean-cut wounds, it is more necessary here, where death of tissue and decomposition are almost certain to occur. No attempt is to be made, however, to close the wound by strapping or similar method. If pieces of the tissue have been torn or pressed out of position, without being wholly separated from the body, they are to be gently replaced, care being taken that they and the parts to which they are restored are perfectly free from foreign particles. The cleaning should, in such cases, be done with the iodine water or other antiseptic. A layer of lint or absorbent cotton, soaked in the antiseptic, is then placed over the wound, and covered with a piece of oiled silk to prevent the dressing becoming dry. If the terebene and oil dressing is used, it should be covered with a layer of absorbent cotton, no oiled silk being necessary. A lightly-applied bandage then secures the whole. The part must be kept absolutely at rest. Probably in two days redressing will be necessary, and if there is much destruction of parts, more frequently.

The Treatment of Wounds of the Head.—Very special care requires to be bestowed on all injuries to the scalp, the risks of inflammation, suppuration, and erysipelas are so great. Here, if anywhere, there is no safety except in the strictest possible cleanliness. Even the coolest person is apt to lose his equanimity at the sight of a mass of hair matted together by clotted blood, from under the edge of which a red stream trickles, and is likely to think that the best thing to do is to cover the whole thing up out of sight, and leave it to providence. This is just the course that must never be adopted. The masses of hair must be quickly parted, till the whole extent of the wound is clearly shown. If the bleeding be little, the person should proceed at once, by means of cold water and pieces of *clean* lint or cotton, to remove all particles of congealed blood, not over the wound only but from every part of the scalp. This must be done thoroughly once for all, and the person must not desist till the hair is completely cleaned, disentangled, and then dried. Then for an inch or so all round the wound the hair should be removed quite close to the scalp by a pair of sharp *clean* scissors. The wound itself must be carefully cleaned by a stream of cold or preferably iodine water. If blood is still oozing from it, a pad of lint wrung out of the water is to be firmly pressed upon it for a minute or two. If the blood be welling out of the wound, the time necessary to complete the cleansing process is too long, and the bleeding must be arrested at once. It will be well therefore to clear a space at once round the wound with the scissors to enable one to get at it thoroughly. But this is not to be done by slashing, haphazard snips, needlessly cutting away large masses of hair. When the wound has been effectually got at, a pad of lint wrung out of cold water or iodine water is pressed firmly into the wound, and if an assistant be at hand he will hold it so, while the person taking charge proceeds to disentangle the hair and clear away clots and foreign material. When all this has been done the wound is to be closed and dressing applied. All clean-cut wounds should be closed as accurately as possible. It is not easy to do this with plaster, because of the difficulty of it securing a hold on the hairy scalp. A surgeon might or might not use sutures, but certainly no unskilled person ought to. The person will do what he can by means of plaster strips, and perhaps by aid of the pressure of small pads of lint on each side of the wound, to bring its lips together. He should apply a dressing of lint soaked in some of the antiseptics named, but preferably terebene and oil or carbolic acid oil, covering lint soaked in any watery solution with oiled silk, but the oily preparation with a dry layer of lint or absorbent cotton, and then fix all with a suitable bandage (see p. 960). If the wound be bruised or torn, no attempt will be made to close it, the antiseptic dressings will be applied, and redressing practised as often as necessary to keep the wound perfectly clean and free from smell. At one time it was not uncommon to pour on the wound friars' balsam, or other sticky substance, to seal it up and help to arrest bleeding. This is only too apt to cause the retention of discharge and dirty material, and is not at all advisable.

The treatment of wounds has been entered into in some detail. This has been done, it is needful to say, not to enable anyone to do without the aid of a surgeon in more than the class of very slight wounds which most people regard as too trivial to require such aid. For anyone who is within reach of such skilled help, and yet attempts to treat a wound of any severity, commits what is really a grave error. It is much wiser, and in the end much more economical, to get immediately competent assistance, when it is at hand, than to be compelled, after some time and when the wound has failed to heal, to resort to a surgeon, when the simple healthy wound has been converted by some excusable error or some circumstance that an unskilled person could hardly be expected to notice, into an unhealthy sore, inflamed by irritation and ulcerous by decomposition. But the author is compelled to have regard to the fact that this book will be in the hands of very many who are remote from medical aid, to whom from geographical or other circumstances any skilled help is simply unobtainable, and who must either attempt to treat such injuries as they best can or let them alone to "go to the bad" or to get well, as circumstances or fortune may determine. It is ridiculous to say that it is useless to attempt to lessen the hardships which such persons are constantly called upon to endure. If it is almost universally admitted, as it now is, to be proper to teach the principles of first aid to the injured to those who live in the midst of large communities, where surgeons are to be found on every hand, it ought to be even more readily admitted to be desirable to place even more extended information within the reach of those isolated from all such resources. Therefore the author has considered his work would not be properly done, unless he stated as clearly and simply as he could the broad general principles which all surgeons accepted as the basis of their practice, and leave these to be applied to each particular case as the common sense of the individual, guided by them, should determine.

The Treatment of Bruises.—The term bruise or contusion (Latin *contundo—con*, and *tundo*, I beat) is restricted to such injuries as are produced by severe pressure, or by a blow from a blunt instrument, or by a fall on a hard substance, when the skin is not broken, or only very slightly broken, as when an **abrasion** has been caused, that is, when the scarf-skin has been removed and the sensitive bleeding true skin uncovered. Bruises may be of all degrees of severity, from that caused by a pinch where only the skin is squeezed sharply, to that which extends into the layers of fat beneath the skin, causing rupture of many small vessels and injury to other deep parts, and to that degree in which the whole tissues of the part may be reduced almost to pulp. Large vessels may be ruptured and extensive bleeding occur, leading even to the producing of pulsating blood tumours, forming a **false** or **diffuse aneurism** (see p. 244). The important point between a bruise only and a bruised wound is that the former is covered by skin which protects the injured tissues from external influences, and especially from the attack of atmospheric agencies, leading to decomposition and suppuration, while the latter is open to all such unfavourable influences. Of so much significance is the protection afforded by the unwounded skin that very serious and extensive bruising of parts may occur, may produce much swelling, inflammation, and pain, and yet recovery occur without the slightest formation of matter or apparent loss of tissue. It will be evident, then, that any method of treating a bruise which breaks through the protective covering of the skin will be highly improper. Nothing could well be more injudicious than the use of leeches or the lancet to reduce the swelling by removal of the effused blood, since thereby a way would be opened for the entrance into the injured tissues of the agents of putrefaction. Yet leeches used to be, and in some classes of society are yet, the resort for such a bruise as that which produces a black eye. Besides the error already noted which such treatment commits, there is another. A leech does not remove blood already poured out from the vessels and diffused among the soft parts, but it opens other blood-vessels and removes fresh blood. The purpose of their application is not served, and the wound they cause adds an altogether unnecessary element of risk.

The first signs of a bruise are redness, swelling, and discoloration. They are all due to the injury done to the soft parts, and specially to the blood-vessels. The swelling and discoloration which follow are caused by the blood poured out of the damaged blood-vessels, and to the outflow of serum from the blood and other elements of blood for the repair of the damage. The discoloration is produced entirely by the effused blood. It may occur within an hour or two of the injury, if it is the surface blood-vessels that are injured, or not for a day or two if deeper parts are injured, while the skin has escaped. Thus it may not appear for twenty-four hours, if the tissue lying immediately beneath the skin is damaged, and will not appear on the surface for some days if the injury has damaged deeper parts, muscles and the tissues between them. In the latter case the discoloration very frequently appears at a considerable distance from the seat of injury, because the escaped blood has gravitated downwards from the injured part.

The technical term applied to this poured-out blood is **ecchymosis**, or **extravasated blood.** Ecchymosis is derived from the Greek *ekchymōsis*, from *ek*, out, and *cheo*, I pour, and the word extravasated is Latin, from *extra*, outside of, and *vasa*, the vessels.

The discoloration resulting from a bruise is at first dark-purplish, and its margin is well marked. In two or three days the margin is spread and less defined, and the colour is more violet in tinge. About the fifth day it is green, in a day or two more yellow, and in one or two more days it has disappeared. The margins show these changes sooner than the centre, so that while the chief part of the discoloration is still dark in colour, bluish or green, the margins are greenish-yellow or yellow, and an irregular mottled appearance results when the blood has been irregularly distributed in the tissues. These changes of colour are due to changes going on in the effused blood, part of the blood being quickly absorbed by the lymphatic vessels (see p. 200) and passed back into the circulation, and undergoing also a bleaching process, as it were, while it lies among the tissues. As the blood and other fluid are absorbed the swelling gradually diminishes, and by the time the colour has become yellow it has almost disappeared. The repair of the parts damaged by a bruise is practically identical with the process of repair already described as going on when a wound heals by first intention. Of course the result of a bruise may be such destruction of tissue that a collection of matter results, which would require removal by an incision; and again in persons of depressed health a bruise might end in an abscess, sloughing of the skin, and so on, which in a vigorous healthy person would have healed without trouble.

A considerable amount of pain, and some degree of inflammation and throbbing, attend a bruise. The degree of pain will largely depend on the amount of swelling, implying more or less pressure on nerves and other sensitive structures, but the inflammation usually soon subsides.

The Treatment of Bruises.—Reasoning from what has been said there are two plain indications of what should be the aims of treatment. First, the swelling and discoloration being the result of the breach of blood-vessels in or beneath the skin and the escape of blood, the immediate thing to do is to stop the bleeding; and if that can be done speedily the swelling and discoloration will be all the less. Second, after all bleeding has ceased, the swelling and discoloration gradually disappear by the removal of the poured-out material by the agency of the lymphatic and other vessels. Any means that will stimulate the vessels to this work will shorten the process.

First, then, what will arrest the bleeding? Cold applications.

Second, then, what will stimulate absorption? Hot applications.

Immediately a blow or fall has been sustained, likely to lead to swelling, &c., resort should be had to cold water. The part should be diligently bathed, the sponge or cloth soaked in cold water being laid on, only for an instant, and then renewed, to maintain the cold. The part affected should meanwhile be held high, not allowed to hang. No delay should be allowed to occur till one learns whether swelling is going to take place or not. In very many cases the swelling may be almost prevented if the cold water be instantly applied, and the more surely will this be the case the more the injury is on the surface, where the cold can act quickly, the less surely the more deep-seated it is. Such applications also greatly relieve the pain and diminish the chance of subsequent inflammation.

In households where cold water is always at hand, a very great amount of needless pain and disfigurement would be saved children if mothers and nurses would instantly rush to the cold water, and not waste time condoling and sympathizing with and kissing the unfortunate child. The cold should not be continuously applied for a long time. A few minutes are all that is necessary, and then after a few minutes' interval another two or three minutes' application. All other popular applications, a coin, a piece of raw beef, derive any value they possess—which is slight at the best—from their being cold. Some astringent lotions are useful, when applied immediately, in diminishing the escape of blood. The arnica lotion is one specially in popular favour, but it should not be employed if the skin is at all broken; and another which seems to be much more useful is the extract of witch-hazel, or hazeline, and which is sold in America as Pond's extract.

After measures have been taken to arrest the bleeding, the bruised part should be kept at absolute rest for a time, and nothing further done for some hours at anyrate to remove any swelling that may have occurred. Specially if the bruised part be in the neighbourhood of a joint must absolute rest be insisted on, not for an hour or two, but till all swelling, pain, and tenderness have passed away. The attempt to use the part earlier than that will certainly be followed by an increase of the swelling.

After the lapse of some hours one may endeavour to hasten the diminution of the swelling. For this warm applications are best, gentle bathing of the part with warm water being the simplest; and if this be repeated at short intervals a speedy restoration to the natural appearance may be expected. Any increase of swelling or pain would be an indication for stopping it and resorting rather to cold. Rubbing the part with one kind of stimulating lotion or another is frequent, but of somewhat doubtful value. Probably of much greater value would be gently but firmly stroking and manipulating the part in the manner described under Massage (p. 772), but such stroking and manipulation ought never to be so performed as to excite pain or renew inflammation.

The employment of such measures, the immediate use of cold, and the use later of warm bathing, is the appropriate means of dealing with a **black eye**; and the same methods should be employed for a strain or sprain of ankle, wrist, &c., combined with perfect rest in a raised position.

A caution is necessary. Where a bruise is very extensive and severe, cold must be applied with great caution and judgment lest the tissues, already much damaged, have their vitality still further lowered. Many very extensive bruises undergo repair with wonderful completeness, if the skin be not wounded anywhere. Probably in extensive bruises the only assistance an unskilled person could render would be to have the person placed comfortably in bed, the bruised part being most carefully handled and supported equally on all sides. If the person has to be carried for some distance, the care with which this is done very often determines the issue, favourable or otherwise.

THE ARREST OF BLEEDING.

The Distinction between Bleeding from an Artery, a Vein, and Capillary Vessels.—The distinction here indicated is one between the kinds of vessels from which the blood is escaping; and if reference is made to pp. 225, 226, the differences will be made plain. The capillaries are exceedingly fine vessels, too minute to be made out without the aid of a microscope. The arteries are of a great variety of size in cross section, but are thick-walled resisting tubes, the smaller ones markedly contractile, the larger ones specially elastic. The larger ones remain open when they are cut across. The veins on the other hand are thin-walled, collapsing when empty, but as readily widening out to a large size when filled with blood. The arteries, consequently, will resist closing by pressure to a considerable extent, while the veins will be easily closed thereby, and the capillaries are quite readily compressed. The flow of blood will be quite easily stopped by comparatively little pressure in veins and capillaries, while that in arteries will persist despite a considerable amount, specially when they are deep-seated and protected by surrounding muscles and other soft parts. From capillaries, and also the more minute arteries and veins, the blood will ooze out, though when the wound occupies a large area much may be lost in a comparatively brief period. A wounded artery may be distinguished from a wounded vein, when both are of a larger size, by the manner in which the blood flows, and its appearance. From a wounded artery the blood will issue in jerks or spurts, corresponding to the strokes of the heart, while from the vein it will pour in a steady stream. The blood from an artery is of a brighter, more scarlet hue than from a vein, from which it is darker or more purplish in colour. Another point it is of importance to notice. From both sides of a wounded vein the blood escapes, but more particularly from the end nearer the extremity of the body, the end farther from the heart, while from a wounded artery the blood escapes only from the side nearer the heart. For the blood in an artery is flowing from the centre of the body to the extremities, while it is being returned in the vein from the extremities to the heart. It is often of importance to observe these distinctions, because, in the event of pressure by a pad or a bandage being necessary to stop the flow, it is clear that in the case of an artery it should be applied on the side of the wound nearer the heart, while in the case of a wounded vein the opposite course will arrest the chief bleeding, or hæmorrhage, as it is called, from the Greek *haima*, blood, and *rhēgnymi*, to burst.

Bleeding is arrested naturally by the sealing up of the wounded vessels by the clotting of the blood at the mouths of the vessels, round about and over them, and within them up to the level of their first branches. Besides, there is poured out of the wound a coagulable material or lymph, further sealing them, and subsequent changes take place, similar to those for the repair of a wound, by which they are effectually closed. As part of the process of repair, the vessels are permanently closed by the formation of connective tissue, such as takes place in a wound, so that after a time nothing is left of the part of the vessel where the wound occurred but a fibrous cord, this change taking place in the whole length of the vessel up to its first branch beyond the seat of injury. Before such changes have had time to occur a renewal of the bleeding may take place by extra pressure in the vessels, causing the sealing to give way and displacing the clots, or by rough handling; and in the case of large vessels it may occur several days after the injury. In such cases it is called **secondary hæmorrhage.** An important element in the natural closing of a vessel is the elasticity of its walls, which, when it has been completely divided, leads it to retract within the wound, when its mouth is closed by the pressure of surrounding tissues. There is, consequently, less bleeding as a rule from an artery completely divided than from one only wounded, since in the latter case the artery is unable to retract.

The Methods of Stopping Bleeding.—The various means of arresting hæmorrhage are as follows:

Raising the Part;
The Application of Cold;
The Application of Pressure;
The Use of Astringent Substances or Styptics.

How does raising the part help to stop bleeding? Suppose blood is flowing from a wound in the wrist. It is plain that if the arm be allowed to hang, a plentiful supply of blood will readily pass down the limb to the wounded part, while the blood returning from the hand will return up the arm less readily, and there will be a determination of blood to the wound; while if the arm be held high up less blood will pass up to the wound, and the blood returning to the heart will do so more readily, with the result of a great diminution in the escape from the wound. Similarly if the foot or lower limb be wounded, the person should lie down or recline, and have the leg raised above the level of the head. Another thing to be attended to is the removal of any hindrance to the ready return of blood to the heart from the injured part. If, for example, a wound has been inflicted on the lower part of the leg, or if a varicose vein has burst, the pressure of a tight garter or similar contrivance will delay the return of blood up the limb and make the bleeding very free. Similarly in the case of bleeding from the hand or arm, clothing tight at the arm-pit, through which the vessels pass, will greatly aggravate the bleeding. When the part is raised, then, all tight clothing should be loosened. Take as another illustration of the same thing, bleeding from the nose. The tendency is for the person to hang the head to prevent the blood flowing on to the clothing, whereas the head should be held high. If the person wears a tight collar, the hanging of the head causes the veins of the neck to be pressed upon, the blood is prevented freely returning from the head, and the bleeding is all the more free. In addition to holding the head up, therefore, see that everything round the neck is loosened. Cold diminishes bleeding by causing the vessels and tissues to contract, and astringent substances like borax, alum, tincture of steel, tannin, friars' balsam, matico, act in the same way. Astringents also coagulate fluid parts of the blood and promote the formation of a scab. Collodion, when it sets, causes contraction of the parts, and also aids in sealing the wounded vessels.

But none of these means of stopping bleeding is equal to that of properly applied pressure, by which the bleeding vessels are forcibly closed. It is applicable to every sort of bleeding, at least from the surface of the body. Pressure may be applied directly on the wound itself in every case, altogether irrespective of the nature and size of the wounded vessels. In many cases the pressure of the thumb laid directly over the wound will be sufficient, and if the pressure be maintained for a little time that may be sufficient to cause the bleeding to cease entirely. If a small pad of lint, or a piece of cloth made into a pad, a strip of handkerchief rolled up, for example, be laid just on the wound and be pressed into it by the thumb, or held firmly on it by a bandage, the arrest of bleeding will be still more satisfactory. But when the bleeding is profuse, the mistake commonly made is to cover over the wound with large pieces of cloth, handkerchiefs, bandages, &c. The result often is that the pressure is spread over a large area, is not properly adjusted over the wounded vessels, and under the mass of coverings the bleeding may go on uninterruptedly. The pad, then, should never be very large. It need never be any larger than is just sufficient to cover the wound, and then it is easy to concentrate the pressure upon the bleeding surface. But while pressure thus applied will be sufficient to arrest the bleeding for a time, it is often insufficient for its permanent stoppage. If a large artery has been wounded the pressure might be kept up for a time, but as soon as it is removed it would start afresh, because the large vessel has not had time to close, and gapes again as soon as the pad is removed. In such a case if pressure were to be maintained long enough to permit complete sealing to occur, the time would probably be so long and the pressure so considerable that the vitality of the tissues would be seriously impaired. Such a method, therefore, while highly satisfactory for a limited time, must give way to others for the permanent closure of the wounded vessel. These methods will be noted in the paragraphs on arterial bleeding. We shall now note the steps to be taken to arrest bleeding under various circumstances.

To Arrest Capillary Bleeding, elevate the part, apply cold water, or the iodine water, mentioned on p. 965. If that is not sufficient fold a piece of lint into a small pad, just enough to cover the wound, and exert firm pressure upon it for a little. The pad may be secured by a bandage. When it is to be removed, it must be thoroughly saturated with water, so that it is washed and not torn off.

To Arrest Bleeding from a Vein.—Follow the above rules, but whenever the bleeding is of any amount apply pressure without delay.

To Arrest Arterial Bleeding.—When the smaller sized arteries are wounded the application of cold and simple pressure is usually enough to stop all bleeding, not only for the time but also permanently. But the larger arteries, if divided, allow blood to escape so rapidly that the bleeding will be sufficient to cause death in a minute or so if uncontrolled. In the case of the smaller vessels there is time to expose the wound, to clean it, to ascertain exactly where the wounded vessel is, and to apply appropriate pressure directly over the spot. But in the case of the larger arteries one must arrest the bleeding immediately in some way or another, and take time subsequently to examine the wound. Then again the place where the artery is wounded may be so deep that it is difficult to get pressure properly applied to it, and although one has applied pressure on the surface the blood may be forcing its way among the tissues. It is clear that the bleeding at the wound would be arrested if the main trunk of the vessel were closed. Thus, suppose bleeding occurring at the palm of the hand which resists all the simple means of stopping it, it is evident that if one could block the main vessel at some part of its course through the arm, the supply of blood to the hand would be arrested and the bleeding would cease. Of course if this blocking were to be maintained for a long period death of the parts deprived of their blood-supply would arise. It must never be forgotten, therefore, that this arrest of the circulation is only resorted to in the emergency, till skilled assistance can be obtained to apply appropriate treatment. Now severe accidents wounding large vessels of one limb or another are not uncommon in large public works, in the harvest field, &c., and there is no manner of doubt that many lives would be saved annually if this method of temporarily arresting hæmorrhage were well known. Even apparently simple accidents frequently end in death from ignorance of such procedure. For example, in the city of Glasgow, a year ago, a beadle of one of the churches, in cleaning a window, accidentally broke a large pane. The glass tore a deep ragged wound across one wrist, opening one of the chief vessels of the forearm. These vessels are so near the surface, and so easily commanded, that, had the man known how, he could easily have stopped the bleeding by his uninjured hand. But he was completely ignorant, and ran to the nearest doctor's house. The doctor was not at home; and he ran to another, and so from one door to another till, from loss of blood, he fell exhausted and speedily died. The smallest amount of knowledge on his own part, or on that of the occupants of the various houses he called at, would have saved his life. We shall, therefore, point out the direction of the chief vessels of the limbs, noting the places where the main trunk comes near enough the surface to be readily commanded, and then show how, by the simplest possible contrivances, bleeding, even from the largest vessels, can be arrested for a time till medical aid can be obtained.

To Arrest Arterial Bleeding from the Arm.—The course of the main artery of the arm is shown in Fig. 367, reproduced from p. 227, where it is more fully described. The artery enters the arm through the arm-pit, midway between the front and back folds, and its course is indicated by a line drawn from the middle of the arm-pit over the arm to the centre of the elbow in front. If one places the thumb on the inner side of the upper arm, midway between the arm-pit and the elbow, and on the line that has been indicated, and if one presses from within outwards, one will press the artery against the bone; its beating will be readily felt, and by increasing the pressure the vessel can be closed. This would stop entirely any bleeding occurring in the forearm and hand, so long as the pressure was maintained. The artery is easily reached, because it is not buried among muscles at any part of its course. In Plate XVI. fig. 11, the fingers are seen pressing in the direction indicated for the purpose of controlling bleeding. The same figure shows another situation in which pressure may be exerted to arrest the supply of blood to the arm. The main trunk of the arm is a continuation of what is known as the subclavian artery (p. 226), and on its way through the chest to the arm it passes behind the collar-bone. In this situation, by pressing the fingers behind the centre of the collar-bone, its pulsations are easily felt, and if

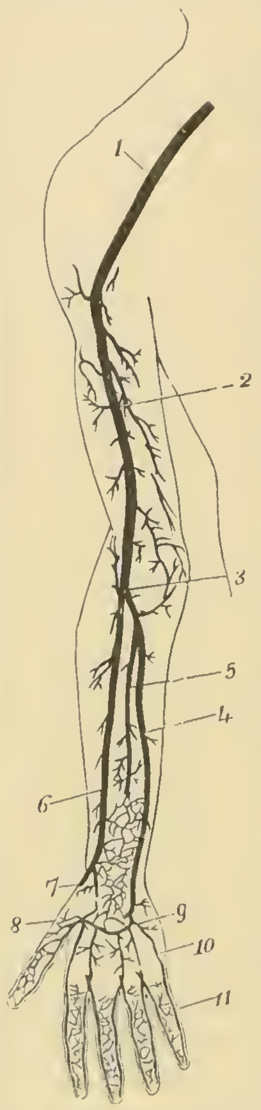


Fig. 367.—Arteries of the Front of the Arm.

1, the axillary artery; 2, the brachial artery, dividing at 3 into 6 the radial, and 4 the ulnar artery, the ulnar giving off a deep branch 5. 7 the radial artery, winding round the back of the wrist to reappear at 8. Between 8 and 9 the superficial arch in the palm giving off branches, as 10, to end along the side of the finger, 11.

very firm pressure be exerted backwards, as well as downwards, the vessel may be compressed against the first rib. Pressure need not be exerted here unless when the wound of the arm is very high up. The handle of a large key, first padded with a piece of cloth, may be used instead of the fingers.

Now while pressure with the fingers is the safest and best method of stopping the flow of blood in an artery, they readily become fatigued; and if any time elapses before aid can be obtained, it becomes necessary to employ some other means. A pad may be placed over the vessel and firmly pressed upon it by means of a bandage. The pad and bandage may be made by the simplest things. A stone wrapped up in a handkerchief to prevent its hard surface injuring the skin may be employed, and secured by another handkerchief applied like a triangular bandage (see p. 962), or a long neckerchief may have a large knot tied upon it, and may then be fixed round the arm, so that the knot presses on the artery (see fig. 6, Plate XVI.), which also shows how the requisite degree of pressure may be employed by slipping a piece of wood, a knife, &c., under the neckerchief after it has been tied, and twisting it up.

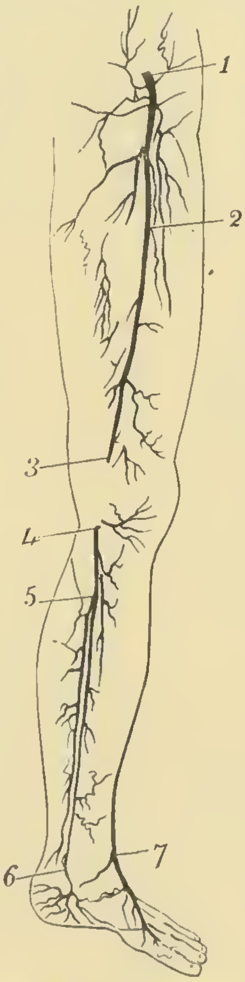


Fig. 368.—The Arteries of the Lower Limb.

1, the femoral artery, passing deeply into the thigh at 2 and winding into the ham at 3; 4, its posterior tibial branch, which passes to the ankle at 6, giving off a large branch at 5; 7, part of the anterior tibial artery shown in Fig. 125.

To Arrest Arterial Bleeding from the Hand it may not be necessary to compress the main artery of the arm. Make a firm pad with a pocket handkerchief, in which a small smooth stone is wrapped: let this be placed in the palm, and let the patient close the hand tightly over it; then secure the hand in this position by means of a bandage. It may also be stopped by the pressure of a pad across the front of the wrist to close both vessels.

To Arrest Arterial Bleeding from the Leg.—The course of the main artery of the leg is shown in Fig. 368, reproduced from p. 228. If the leg be turned somewhat outwards and the knee be half bent, a line drawn from the middle of the groin over the thigh to a little above the inner side of the knee-joint indicates its course. Such a line is shown in figs. 1 and 2 of Plate XVI. In the upper third of the thigh, the vessel is not covered by muscles, but lies under the skin and fat. Pressure exerted here will close the vessel and so arrest bleeding lower down. Fig. 10 of Plate XVI. shows how the thumb of each hand may be placed alongside of each other to accomplish this. Here certainly it would be difficult to maintain efficient pressure for any length of time, and the use of a pad of some kind is necessary. Fig. 2 shows the application of a knotted cravat, twisted up by means of a knife to accomplish the end desired.

When, however, the bleeding occurs in the foot or lower leg it is not always necessary to block the vessel so high up. From the inner side of the knee the vessel passes back into the space behind the knee-joint, the ham, and pressure may be exerted quite effectually here by placing a roll of bandage, a stone wrapped up in cloth, &c., in this space, and tightening it up as shown in fig. 9, Plate XVI.

To Arrest Bleeding from the Head and Neck, keeping the head high, employ cold water, and apply firm pressure directly over the wound. Fig. 369, reproduced from p. 227, shows the position of the main arteries. When the head is thrown back and to the side the line of one of the chief muscles of the head and neck is shown in relief, and this muscle covers the main

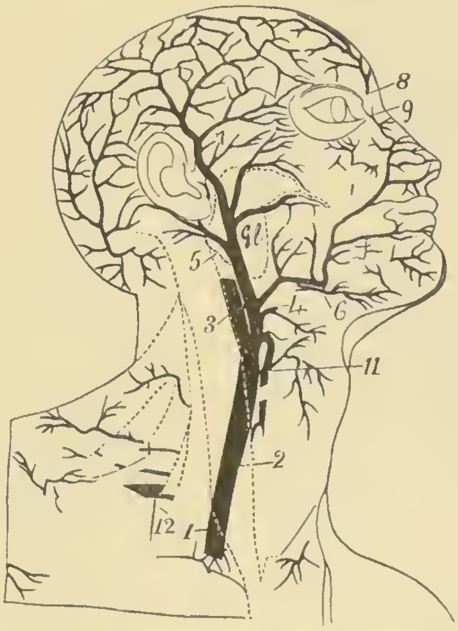


Fig. 369.—Arteries of the Head and Neck.

1 and 2, the common carotid artery, 2 being the part covered by muscle as indicated by dotted lines; 3, the internal, and 4, the external carotid. Some branches of the external carotid are shown, 5 to parts behind the ear, 6 to parts under the chin, 7 to the side of the head, and 9 to the nose. 8 points to a branch of the internal carotid which comes out from within the skull above the eye and is distributed over the forehead. 11 is a branch passing down to the front of the neck. 12 points to part of the subclavian artery. *Gl* shows the position of the salivary gland.

artery and protects it from injury up to the level of the angle of the jaw, and beyond which the artery lies less deeply, where it divides. Firm pressure here will be necessary if the arteries beyond be wounded. In cases of cut throat branches from these vessels are often wounded, but bleeding may be arrested by direct pressure on the wound, and by pressing the edges of the wound together between fingers and thumb.

To Arrest Bleeding from the Nose, let the person sit erect, holding the head high; let a large sponge soaked in cold water be held over the nose. If this is not sufficient, as it commonly is, let the nostrils be held firmly for a little, or let cold water, or cold water with borax or alum dissolved in it, or the iodine water mentioned on p. 969, be gently injected by means of a syringe up the nostril. If this is still insufficient the nostril should be plugged by means of a piece of lint, rolled up in the shape of a cone and pressed up, small end first, into the nostril, the large end projecting outwards. Sometimes it is necessary to plug not only the external openings of the nostril, but also the internal opening, that leading into the back of the throat. This, however, can be done only by a surgeon.

Tourniquets (from the French *tourner*, to turn) are appliances used to check bleeding. The pad and bandage, tightened by the twisting of a piece of stick, is a rough and ready made tourniquet; and in Plate XVI. figs. 3, 4, and 7 show various forms. The ordinary form of tourniquet consists essentially of a pad to be placed over the artery to be compressed, of a strap to fix it, and a screw to tighten it. Fig. 4 in the plate shows Petit's tourniquet. The figure shows it provided with a pad, but besides the screw it may consist only of a strap of stout webbing and a buckle. A roller bandage is then used as pad. It is unwound a little; the roller being placed over the artery the end is passed once or twice round the limb to fix the bandage. Then the strap is put round over it, so that the screw is on the opposite side of the limb and the buckle between the screw and pad. The strap being pulled through the buckle and fixed, it is then rapidly tightened by turning the screw. This must be done rapidly, else the veins would be compressed a little before the artery, being nearer the surface than the artery; the blood being prevented returning from the limb before it was stopped passing down into it, the limb would be overcharged with blood. Fig. 3 of the plate shows a tourniquet made of a piece of wood, through slits in which the strap is passed, the strap having a pad fixed to it. After the strap is tied it is rapidly tightened by twisting it up with a piece of wood. Fig. 7 of the plate shows a tourniquet made of a long india-rubber band, as thick as one's little finger. It passes through a block of hard wood, and a channel is cut in the block of such a size that the india-rubber can pass into it only when it is well stretched, and it prevents the band from slipping as soon as the stretching force is removed. In fig. 8 it is shown applied. The rubber band is passed once fully round the limb, and then both ends are brought round, and are so strongly stretched that they are able to pass into the groove where they are gripped.

Bleeding from a wounded artery is permanently arrested by the artery being tied either at its wounded end or in its course at a little distance from the wound. Fig. 5 of Plate XVI. shows a pair of artery or catch forceps. By means of these the end of a cut artery is picked up. The forceps being then shut, the spring keeps them so, and the mouth of the vessel is kept closed till a ligature is put round it and tied, after which they are released.

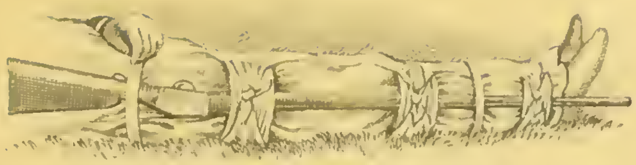
It must be observed that it is never necessary to apply a tourniquet to stop bleeding from a vein. Direct pressure over the wound by a pad held firmly by the fingers, or a pad secured by a bandage, will always be found effectual.

POISONED WOUNDS, INSECT STINGS, SNAKE BITES, AND OTHER KINDS OF POISONED WOUNDS.

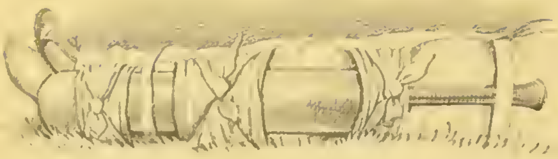
Poisoned Wounds are dangerous out of all proportion to the size or situation of the wound, and out of all proportion also to the amount of poisonous material which has gained entrance to the body. For the poison is almost invariably of animal origin, capable of multiplying in the tissues and blood, and, just as "a little leaven leaveneth the whole lump," is capable of profoundly affecting the whole body. The description given in Section XIII. (p. 384) of the action of minute organisms is applicable to the way in which poison introduced by a wound affects the body. The material introduced sets up changes in the part of the nature of fermentation, and may be limited to the immediate surroundings of the wound, leading only to the formation of abscesses or ulcers, but may extend along the blood and lymph channels, reaching glands and setting up inflammatory action in them, and perhaps leading to changes

TEMPORARY TREATMENT OF FRACTURES.

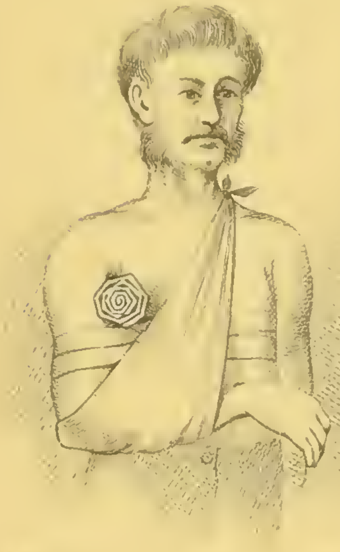
Plate XV



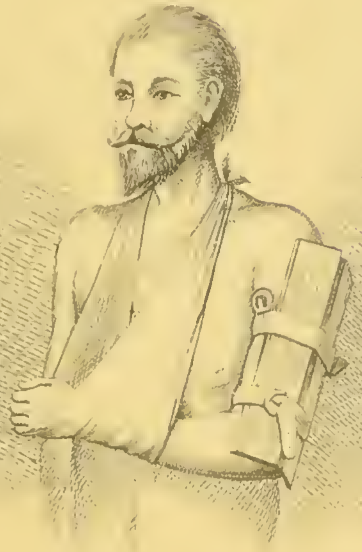
Rifle applied as splint to a broken thigh bone



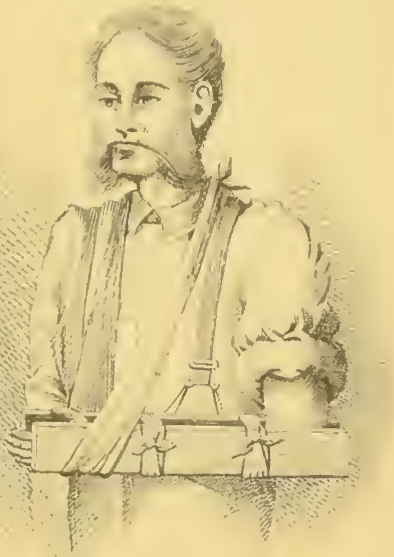
Cricket bat applied as splint to broken lower part of leg



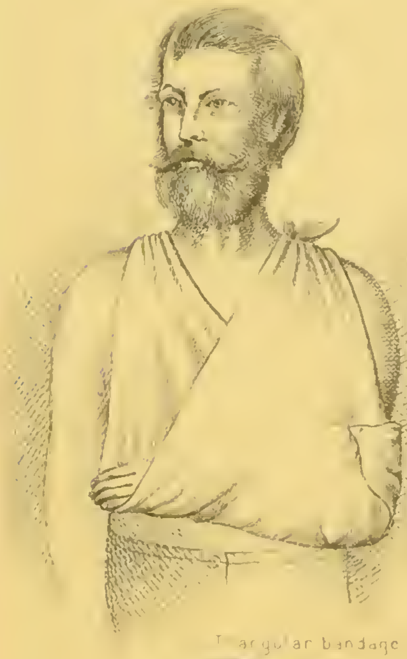
Temporary treatment of broken collar-bone



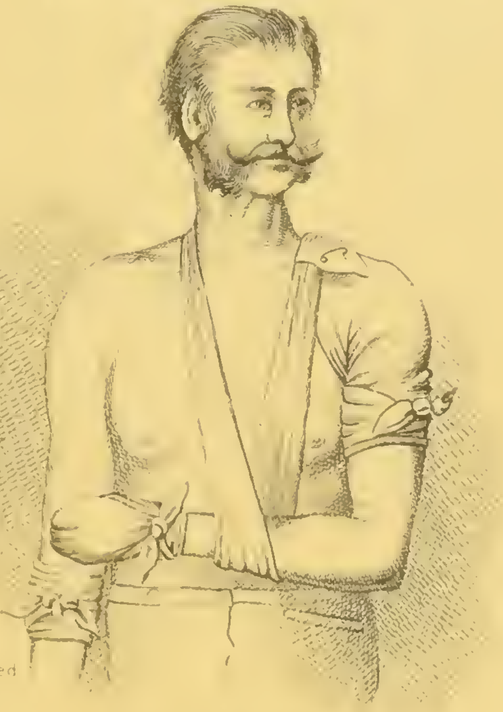
Splints applied to broken upper arm



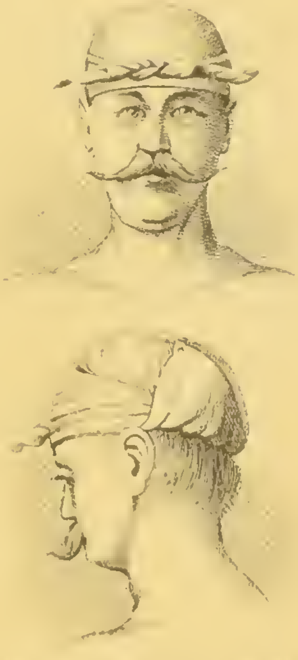
Splints applied to broken forearm



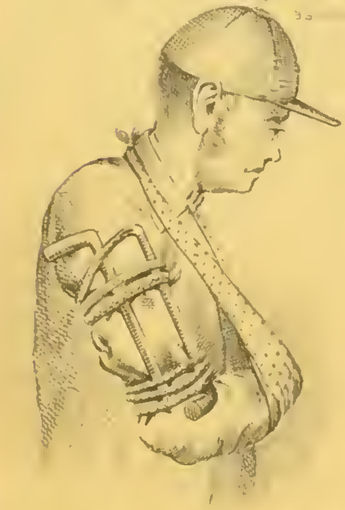
Triangular bandage adapted as sling for arm



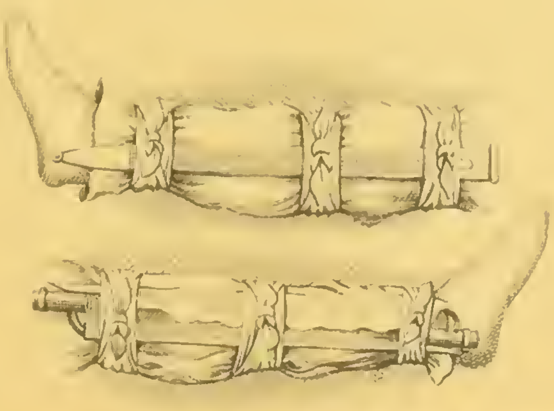
Bandages for shoulder, hand, elbow, and a small arm sling



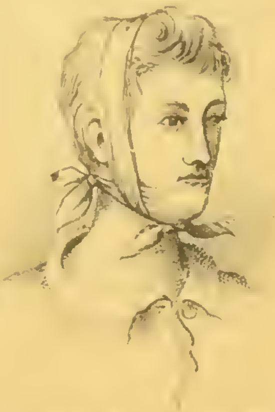
Triangular bandage arranged as "shawl cap" for the head



Temporary splints of huntsman's whip for broken upper arm



Broken fore leg with scabbard and bayonet as splints



Handkerchief applied as bandage for fractured lower jaw

in the blood, showing themselves in fever, diarrhœa and all the symptoms of blood poisoning (p. 236). Now the poisonous material may be on the instrument with which the wound was inflicted. For example, wounds received by medical students in the dissecting-room, by a surgeon performing a post-mortem examination, by a veterinary surgeon or others during the process of cutting up or removing the hide from an animal which has died of some disease, are all of a very serious nature, since the knife with which the wound was inflicted is smeared with the juices from the dead body, which are thus directly introduced to the tissues of the person. Insect stings, bites of venomous reptiles, &c., belong to the same class, but will be discussed separately.

The wound, however, may have originally been perfectly clean and healthy, and foul material may gain entrance to it later, and convert it into a poisoned wound. This may happen in an infinite variety of ways. A person with a wound upon the hands, however slight, who handled a foul sore or ulcer without precaution or came into contact with unhealthy discharges would run great risk. Similarly anyone who had dressed or assisted in dressing unhealthy wounds or sores of one person, and went straight to assist in the dressing of another person who had a perfectly clean and healthy wound, would be almost certain to infect the clean wound with material from the unhealthy one. Surgeons are now exceedingly careful and scrupulous in this respect, and adopt all manner of precautions, not only to ensure the thorough cleanliness of their hands and instruments, but also to ensure that their clothing may not be a source of danger. It is surprising how small a wound, a mere scratch and mere prick with a pin or needle, may offer sufficient entrance room to foul material. The author was awakened one night by pain and throbbing of his right thumb. By morning the whole thumb was red, swollen and tender, and a broad pink band of inflammation passed from the thumb over the wrist and up the front of the arm to the inner side of the elbow, where happily it stopped. This was acute inflammation of lymphatic vessels (see p. 206), due to a poisoned wound, but there was neither wound nor scratch apparent. But after a little thought the cause was clearly traced. He had accidentally pricked his thumb with a pin, a perfectly clean and harmless pin. But an hour or two later he had to treat at a public dispensary a large number of cases of eye disease, including several cases of a form of inflammation attended by copious discharge of a very contagious character from the eyelids. During the holding open of the lids with the thumb and forefinger, some of the infective material had crept into the minute and forgotten pin-prick, and though, immediately after the case had been treated, the hands had been carefully disinfected and washed, still enough had gained entrance to give trouble, though fortunately only for a few days. No one, then, can be too careful in dealing with foul sores or discharges, and no scratch or broken skin, however small, is so insignificant as not to need protection in the presence of such unhealthy wounds.

Some persons seem to be peculiarly invulnerable to risks of this description, while other persons are peculiarly liable. Undoubtedly also the tissues of some persons resist the operation of such morbid material more strenuously than those of others; and it is equally certain that the state of one's health at the time affects in a very marked way the degree of resisting power. Thus a person in depressed general health is much more apt to be affected by poisoning in a wound than another in robust health.

The symptoms that attend poisoning in a wound are redness, pain, and swelling in and around the wound, with the formation of matter, and perhaps the death and separation of some part of the tissues. Then the redness extends along the lines of the lymphatic vessels leading from the site of the wound up the limb, and these vessels are marked out by fine red lines, which, as the inflammation extends, become broader and merge in one another. These lines meet in the nearest gland, which may become inflamed and swollen also, and be hard and tender, and may end in becoming a collection of matter. Here the process may cease, but on the other hand, it may continue its course up the limb, and produce attacks of shivering, fever, and all the symptoms of blood poisoning, which need not be detailed here, since they have been discussed on p. 236. Reference also to p. 206 and p. 207 will explain the effects on lymphatic vessels and glands.

The Treatment of Poisoned Wounds.—In the first place what is to be done when a wound is received from an instrument known to be foul? It should be immediately thoroughly washed with a stream of clean water. If carbolic acid is at hand, or Condy's fluid, it should be added to the water. The corrosive sublimate solution (p. 912), supposing it to be at hand, would be the most useful. But in most cases some delay is inevitable, and meanwhile the poison would be absorbed. Therefore the speediest method, and one always at hand, is to grip the part immediately above the wound as tightly as is possible, to arrest the circulation, and vigorously suck the wound with the mouth to remove the poison. As soon as possible thereafter it should be washed. Further to ensure destruction of the poison the wound should be touched all over its surface with lunar caustic (nitrate of silver). It should then be covered with a piece of lint smeared with vaseline, or carbolized vaseline, or soaked in carbolic oil. The lunar caustic destroys only a fine surface film of the tissue, and when this has separated a healthy wound is left. If any of the strong acids, nitric, for example, be at hand, it may be employed instead of the caustic. But this agent is so destructive that it must be applied with great care. The best way is to dip a piece of wood, the end of a match, if nothing better can be had, into the acid, shake off the drop that adheres and then pass the end lightly over the surface of the wound, care being taken not to touch any of the uninjured skin. The wound is then bathed with cold water and bound up as before advised. Another very effective method is to heat to *a white heat* the end of a knitting needle, or failing anything better, the end of a long nail, and pass it over the whole surface of the wound, then apply cold water dressing to subdue inflammation, and frequently renew it. If the iron be heated to a white heat the pain inflicted by the application is comparatively trifling

In the event of a wound, believed at first to be quite clean, showing signs of having been poisoned, the dressing must be immediately undone. If a pustule or boil or abscess has formed, it should be freely laid open by a sharp knife, and every particle of matter cleared out, and the wound thoroughly mopped out with carbolic or other antiseptic lotion (p. 912). The raw surface might then be touched all over with caustic or strong carbolic acid, or other acid, washed again in a stream of cold water and then dressed as already suggested. Frequent antiseptic cleansing would be afterwards necessary. Treatment of further complications is sufficiently explained under the headings of blood poisoning and inflammation of lymphatic vessels and glands (pp. 236 and 206).

Now although these directions have been given to meet emergencies, and the case of those who are out of reach of medical aid, the consequences that may ensue are so grave, and their treatment requires so much constant care and skill and knowledge, that no delay should be allowed to take place and no trouble spared in obtaining competent medical aid.

Stings of Insects.—Bees and wasps are in this country and in America the insects which have the greatest number of victims by their stings. It is quite a common thing in summer to see recorded the narrow escape of a person from being stung to death, and now and again actual death of an adult or child. As regards bees these accidents seem to be most common about the time of the casting off of a swarm, and numerous are the instances reported of a swarm settling on a person's head, and being skilfully "hived" without the slightest injury to the person. Thus we take the following story of an old English bee-master, Thorley, as an illustration. "In the year 1717, one of my swarms settled among the close-twisted branches of a codling tree, and not to be got into a hive without help. My maid-servant being in the garden, offered her assistance to hold the hive while I dislodged the bees. Having never been acquainted with bees, she put a linen cloth over her head and shoulders to secure her from their stings. A few of the bees fell into the hive, and some upon the ground, but the main body upon the cloth which covered her garments. I took the hive out of her hands, when she cried out that the bees were got under the covering, and were crowding up towards her breast and face, which put her into a trembling posture. When I perceived the veil was of no further service, she gave me leave to remove it; this done, a most affecting spectacle presented itself to the view of all the company, filling me with the deepest distress and concern, as I thought myself the unhappy instrument of drawing her into so imminent hazard of her life. Had she enraged them all resistance would have been vain, and nothing less than her life would have atoned for the offence. I spared not to use all the arguments I could think of, and used the most affectionate entreaties, begging her with all the earnestness in my power to stand her ground, and keep her present posture; in order to which I gave her encouragement to hope for a full discharge from her disagreeable companions. I began to search among them for the queen, they having now got in a great body upon her breast, about her neck, and up to her chin. I immediately seized her, taking her from the crowd, with some of the commons in company with her, and put them together into the hive. Here I watched her for some time, and as I did not observe that she came out, I conceived an expectation of seeing the whole body quickly abandon their settlement; but instead of that, I soon observed them gathering closer together without the least signal for departing. Upon this I immediately reflected that either there must be another sovereign, or that the same was returned. I directly commenced a second search, and in a short time, with a most agreeable surprise, found a second, or the same. She strove, by entering farther into the crowd, to escape me; but I reconducted her, with a great number of the populace, into the hive. And now the melancholy scene began to change to one infinitely more agreeable and pleasant. The bees, missing their queen, began to dislodge and repair to the hive, crowding into it in multitudes, and in the greatest hurry imaginable; and in the space of two or three minutes, the maid had not a single bee about her, neither had she so much as one sting—a small number of which would have quickly stopped her breath." The queen-bee, it may not be out of place to remark, is distinguished from the others by the considerably greater length of body, the upper portion being of a deeper black than that of the workers, while the under surface and the limbs are of a rich tawny colour. The legs are longer, but without hairy brushes at the joints; the proboscis is more slender, and the hinder pair of legs are without the cavity possessed by the others for collecting farina. In the breeding season the body is greatly swollen and elongated. The notable point of the above story is the harmlessness of the bees during the swarming season, when they are intent upon following the queen-bee, provided they are not excited or enraged by being injured or crushed. Many people directly court attack from bees and wasps by the wild state of excitement into which they allow themselves to be thrown by the approach of an insect, and the frantic efforts they make to get at it with a handkerchief, or to drive it off. Much less risk is run if the person will quietly move off, and at anyrate forbear exciting the insect by such means.

Many persons are peculiarly susceptible to the sting of bee, or wasp, or other insect, the part bitten becoming speedily inflamed, much swollen, and painful. Others again are much more tolerant. A single sting on the eyelid, or in its immediate neighbourhood, will, in susceptible persons, soon cause so much swelling that the eye is closed up. Death has resulted in such persons from a single sting. Cases of stinging in the throat have occurred, death arising from suffocation by the great swelling occasioned. Death is usually due, however, rather to the shock of numerous stings and the collapse they produce.

The treatment of such stings is similar to that for much more serious insect stings, snake bites, &c. In the case of the bees and wasps the sting is often broken off and left in the wound. It should be immediately removed with fine tweezers, and then some alkaline remedy is applied to destroy the acid character of the poison introduced. Lime, chalk, baking soda, moistened with water, are all useful and materially diminish the pain. Even loam is useful. But best of all is ammonia water (hartshorn) or aromatic spirit of ammonia freely applied. A popular and very useful remedy is the leaf of the common dock, bruised, the juice being rubbed into the wound, after withdrawing the sting, for ten or fifteen minutes. A poultice of ipecacuanha is believed by some to be an antidote for every kind of poisonous bites. Cold water applications continuously applied for some time will relieve the pain and diminish the swelling. Olive-oil, vinegar, laudanum, are also recommended, or a lotion of a tea-spoonful of sugar of lead dissolved in a teacupful of cold water. If the throat is stung the sting should be removed if possible. Fifteen drops of ammonia water, well diluted, may be given to sip, and repeated in a quarter of an hour, ice to suck, warm water and salt with which to gargle the throat, and cloths wrung out of hot vinegar and water are wrapped round the neck. If the swelling threatens suffocation a surgeon would lessen its amount by scarification, while if the shock is great other stimulants are necessary, hot whisky, or brandy and water, along with 20 drops of laudanum, repeated in an hour, if needful, to diminish the pain. In such cases the opening of the windpipe—tracheotomy—might be necessary to permit of breathing.

The Mosquito is another common pest of warm climates. Its bite is inflicted by a long lancet-like organ of six bristles, folded together in a grooved sheath. After the bristles penetrate the skin the blood is drawn by the channel found between them. The treatment is the same as for the sting of the bee or wasp.

The Chigoe (*Pulex penetrans*) (Fig. 370), Chique, Pique, Bicho, or Jigger is very common in the West Indies and tropical America. It attacks the feet, the female burrowing beneath the skin, and forming a little cyst in which it lives until the body is distended with eggs. The small swelling is then of the size of a pea and of a bluish colour, and it occasions violent itching. It penetrates chiefly under the nails. The cyst can be extracted entire with the point of a needle by those expert at it; but if it is broken and the young escape severe inflammation arises. The means of prevention is constant cleanliness, and the wearing of covering on the feet whether in or out of doors.

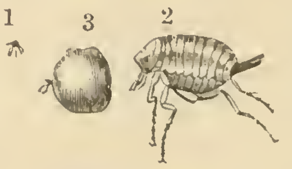


Fig. 370.—Chigoe.

1, male chigoe of the natural size; 2, the same magnified; 3, a female full of eggs, natural size, as taken from a human toe.

Ticks of many varieties abound in the tropics. They bury the head under the skin and suck the blood in that position. When the body is pulled away the head is usually left, and should be extracted with tweezers; nicking the skin with a sharp knife aids the process. The use of very hot water aids their removal, lessening the risk of breaking off the head.

Midges are a common pest, and on some people produce much swelling and painful itching. Whisky is often applied to the skin to relieve the pain, and those whose face readily becomes swollen find much benefit by laying a piece of cloth soaked in the whisky over the skin. An ointment made of 60 drops oil of pennyroyal to one ounce of vaseline, lard, or other simple ointment, smeared on the face is a useful preventive. Equal parts of wood tar and sweet-oil are also used to smear exposed parts. Camphor and lemon juice are also used; and carbolic acid sprinkled freely about a room prevents their attack. But mosquito curtains well arranged are a necessity. Those who camp out use a smouldering fire of green wood, placed where the smoke is blown about the tents, as a prevention to attacks both of midges and mosquitoes.

Bed-bugs (*Cimex lectularius*) are not easy to dislodge when they gain a footing in a wooden bed. One of the best applications is a mixture of three parts petroleum and one hundred parts of water. This is applied to all cracks and crevices of woodwork. Beds should be scalded with boiling water. Fumigation with sulphur is an effectual remedy. Bed-bugs are said not to venture from their corners except in the dark, and that if even a feeble light be kept burning in a room all night they will keep in confinement.

Spiders of various kinds are also very obnoxious. There is the black spider of the northern parts of America, whose bite causes sometimes much pain and inflammation, and the **Tarantula** of the south-west, a large spider capable of inflicting a severe bite, which may be followed by severe shock and inflammation. Such bites are to be treated in the way recommended for the stings of bees, ammonia lotion and a poultice of ipecacuanha specially being recommended.

The Scorpion and Centipede are common in the southern states of America, and in Asia and Africa; and they there attain a large size, the latter often being from five to seven inches long. The scorpion belongs to the spider class; and carries its sting as a hooked claw prolonged from the abdomen. At the base of the claw is the poison gland, a fine channel running to the point. In the latter the offensive weapon is part of the jaws, hooked in form, and perforated with a fine canal for the discharge of the poison. The bites of these animals are often very severe, causing serious inflammation, great depression of vital powers, and much collapse. They are to be treated in the same way as stings of bees and wasps, ammonia and whisky being applied to the part, and stimulants given internally. To remove the poison from the wound small incisions are made and encouraged to bleed, and the wound may be sucked, if no scratch exists on the lips or mouth. The use of cupping glasses after scarification is also recommended.

The Guinea-worm (*Dracunculus* or *Filaria medinensis*) is in one stage a minute animal inhabiting water or moist soil, and common in the East Indies and on the coast of Africa. It attacks those exposed to it owing to bare feet and legs, pierces the skin and then proceeds to develop the worm form in the loose tissue. It is the female only that is known. In this situation it grows to a length varying from one to six feet, of the thickness of vermicelli, and it reaches its maturity, when its body is filled with eggs, in about nine months. Much pain, stiffness, and swelling accompany its growth, and finally a large bleb filled with fluid rises on the skin, usually in summer. When the raised

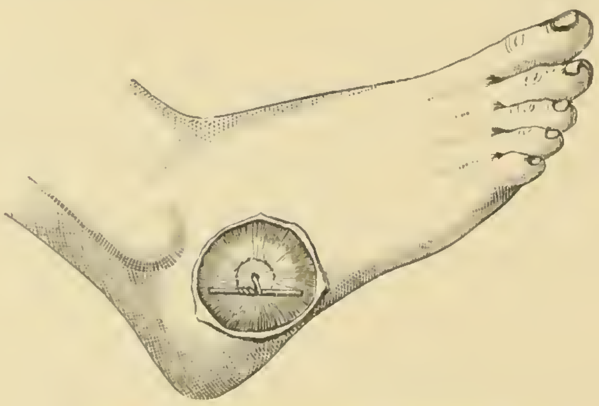


Fig. 371. Mode of Extraction of Guinea-worm.

cuticle has been removed, the head and an inch or more of the body of the worm are seen projecting from the centre of the raw surface. An abscess may be formed, and when it is opened the head of the worm is found. It is removed only gradually by twisting the fine end of the worm round a piece of adhesive plaster, rolled into a quill shape, or round a piece of wood such as a match, and then every day a turn or two is given to the plaster or match, the worm being gradually wound upon it, no violence being used lest the body be torn (Fig. 371). After a more or less prolonged period the tail of the worm is reached, recognized by its hook-like appearance.

Snake-bites.—All snakes and serpents are not venomous, though all are capable of biting. One of the main distinctions between those that are poisonous and those not so is that the poisonous reptile, as a rule, has no ordinary teeth in the upper jaw, but has instead two long curved conical fangs. These fangs, when not in use, may be concealed in folds of the lining membrane, but when the jaw is opened they are erected to strike. Connected with each fang is the poison gland, one of the glands of the mouth, which has undergone special development, and a duct from the gland passes to the fang, which is perforated to the point by a fine channel down which the poison can be discharged, when the animal strikes. Behind these upper jaw-bones the palate bones carry a row of teeth, fitted for seizing and holding or squeezing prey, but not for chewing. In non-poisonous reptiles the poison fangs are not present, but there is a row of teeth in the ordinary position in the upper jaw, and rows of the palatine teeth behind them. Fig. 372 shows the head of a venomous snake—a viper, while Fig. 373 shows the head of the British snake, which is destitute of these fangs, and is therefore harmless. The forked tongue seen protruding from the mouth in each case is not capable of doing harm. It is formed by two muscular cylinders united towards their base but free at their extremities, and used rather as an organ of touch than of taste.

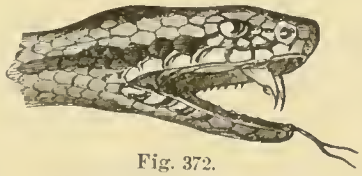


Fig. 372.
Head of Poisonous Snake.

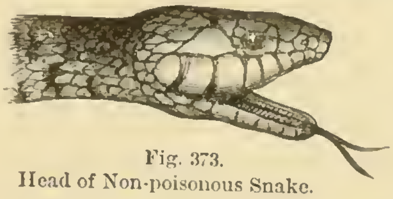


Fig. 373.
Head of Non-poisonous Snake.

Among the non-venomous snakes are the common **ringed snake** of Britain, already mentioned, the **black snake** (*Bascanion constrictor*), and the **pythons** and **boas**, which include the kinds popularly known in America as the **anaconda**. These latter, all belonging to the boa family, include the largest and most powerful animals of the serpent species. Though their bite is harmless they are very destructive, because of their power of winding themselves round the bodies of their victims and crushing them into pulp in their coils, preparatory to swallowing them.

To the venomous serpents belong the **common viper**, occurring in England and Scotland, which inflicts a severe bite, but not commonly deadly except in the case of children and feeble persons, and the American **rattlesnake** (*Crotalus horridus*), which is very deadly. The rattle is due to a series of horny scales, jointed to one another, at the end of the tail, the shaking of which, when the animal throws itself into a coil, makes the noise. The **water viper** or **moccasin** (*Cenchris* or *Ancistrodon piscivorus*), found in swamps in warmer parts of America, the **copperhead** (*Trigonocephalus contortrix*), the **cotton-mouth** (perhaps a variety of the copperhead), and the **harlequin-snake** (*Elaps fulvius*), are all venomous and found in America. In Brazil and Central America is found a poisonous variety, of the same species as the rattlesnake, and called the **jararaca**; in Australia the **tiger-snake** and **death-adder** (*Acanthophis tortor*) are venomous; in Africa the **horned-snake** (*Cerastes cornutus*) and **puff-adder** (*Clotho arietans*) of the Cape of Good Hope, and the asp (*Naje haje*) are the best known and most dreaded. In India, where it is calculated 20,000 natives die annually from snake-bite, the chief poisonous serpents are the **cobra**, cobra-di-capello (*Naja tripudians*), the **bungarus** or **rock-serpent**, **Russell's viper** (*Daboia*), chain-viper or tic polonga of Ceylon, and the *Ophiophagus Elaps*.

The cobra is also called hooded or spectacled snake, because the skin of the neck is very loose, and can be distended to cover the neck like a hood, while the ocelli on the back of the neck produce the spectacled appearance.

Besides those named, poisonous sea-snakes abound in the Indian and Pacific Oceans.

The effects of a snake-bite, as well as those of stings, depend on the amount of poison injected into a wound. This is not the case with poisoned wounds, such as dissection wounds, wounds poisoned by putrefactive material. The poison injected in the case of the snake-bite is not capable of multiplying in the system. It contains an alkaloid, according to some, acting by chemical activity. If one has been thoroughly bitten, a double wound should be seen, the punctures of the two fangs, half an inch apart. Intense pain and swelling occur at the bitten part, extending up the body. Symptoms of shock quickly come on, giddiness, loss of speech, clammy sweats, dimness of vision, faintness, weakness, sickness and vomiting. Drowsiness, stupor, unconsciousness, and perhaps convulsions occur. Death occurs generally within two hours, but may be more speedy, and death is almost certain if a full dose of poison has been injected by the animal. But if a small dose of the poison has been received, or the venom is inert from some condition of the serpent, recovery may ensue, even after threatening symptoms have been shown.

Treatment of Snake-bite is thus laid down by one of the greatest authorities on Indian poisonous serpents, Sir Joseph Fayrer: "When a person is bitten by a poisonous snake, send at once for the doctor. Pending his arrival, apply a ligature, made of a piece of cord, round the limb or part at or about 2 or 3 inches above the bite. Introduce a piece of stick or other lever between the cord and part, and by twisting tighten the ligature to the utmost. Apply two or three ligatures above the first at intervals of 4 or 6 inches, and tighten them also. After the ligatures have been applied, scarify by cutting across the puncture to the depth of $\frac{1}{4}$ inch, with a sharp penknife or other cutting instrument, and let the wounds bleed freely, or better still, excise the punctured and poisoned part. Apply either a hot iron or live coal to the bottom of these wounds as quickly as possible, or some carbolic or nitric acid. If the bite be not on a finger or toe, or on a part where the ligature can be applied, raise up the integument with the finger and thumb, and with a sharp penknife cut out a circular piece as big as a finger nail round each puncture, that is, round the points of the finger and thumb, to the depth of $\frac{1}{4}$ inch. Then apply the hot iron to the bottom of the wounds, and wash the part with solution of permanganate of potash. Give fifteen drops of liquor ammonia, diluted with water, immediately, and repeat it every quarter of an hour, for three or four doses or longer, if symptoms of poisoning appear, or give hot brandy or other spirit, with an equal quantity of water, about an ounce of each for an adult, at the same intervals. Should no symptoms of poisoning come on in half an hour the ligatures should be relaxed, or the part will perish from gangrene. If depression, faintness, nausea, hurried respiration, and exhaustion supervene, the ligature should not be relaxed until the person is recovering, or until the ligatured part is cold and livid.

Another plan lately introduced by M. de Lacerda is not to scarify, excise, and cauterize, &c., but to inject into the site of the bite a 1 per cent filtered solution of permanganate of potash, the object being to follow up and neutralize the poison. If by this method a sufficient quantity of the antidote could be accurately brought into contact with all the virus in the tissues (the mixture of snake poison and solution of permanganate of potash out of the body, when injected under the skin, is quite innocuous) it might prove an effectual remedy; and we are glad to observe that Mr. Richards is zealously prosecuting a series of experiments, with a view to determine the value of the practice.

Sucking the wounds may be beneficial, but as it may be dangerous to the operator it cannot be enjoined as a duty. If, however, it be practised, rinse the mouth thoroughly both before and after the procedure, with the permanganate of potash solution. If symptoms of poisoning set in and increase, if the patient become faint or depressed, unconscious, nauseated, or sick, apply mustard poultices or liquid ammonia on a cloth over the stomach or heart; continue the stimulants, and keep him warm, but do not shut him up in a hot stifling room or small native hut; rather leave him in the fresh air. Do not make him walk about if depressed; nurse him with stimulants, mustard poultices or ammonia, but let him rest. If the person be seen some time after the bite has been inflicted, and indications of poisoning are present, the same measures are to be resorted to, or the new method of M. de Lacerda may be adopted. They are less likely to be successful at this late period of the case, but nothing else can be done. In many cases the prostration is due to fear; the bite may have been that of a harmless or exhausted snake, and persons thus bitten will, of course, rapidly recover under the use of the above measures. If poisoned, but, as is frequently the case, not fatally, these measures are also the most expedient; if severely poisoned, no others are likely to be more efficacious. People should be warned against incantations, popular antidotes, and loss of time in seeking for skilled aid. The remedial means suggested are no doubt severe, and not such as under other circumstances should be intrusted to non-professional persons; but the alternative is so dreadful, that, even at the risk of unskilful treatment, it is better that the patient should have a chance of recovery."

The two objects of this treatment are, first, to remove the poison before it can get into the circulation, if possible; and second, to maintain the strength of the patient by stimulants till any poison that has gained entrance to the blood is expelled by the ordinary excretory channels. For the latter purpose whisky is much relied on, and is given at frequent intervals, even to the point of symptoms of intoxication beginning to show themselves. Under the circumstances, however, very large quantities can be given without intoxication being induced; but it is needful to observe that that condition is not desired.

Bites of other Animals.—Hydrophobia is the only disease requiring mention as resulting from the bites of dogs, cats, foxes, &c., and it has been discussed on p. 421.

The Poison of Venereal Disease.—There is one disease of this class, due undoubtedly to a special poison, which has been already described elsewhere (p. 422). There are other two affections, occasioned also by the introduction into the body of morbid material, but whether they are as truly the result of specific poisons is not so certain. The one is **soft chancre**, chancroid ulcer, or the soft sore, so called in contradistinction to the hard sore, which is the first step in the production of syphilis; the other is an inflammation of the urinary passage, called **urethritis or gonorrhœa.** The soft chancre is a simple ulcer, with a ragged irregular floor, with an abundant yellow discharge; and the tissues beneath it are not condensed and hardened as in the other variety; but, though they may be puffy and swollen, are of the natural softness and mobility. This ulcer tends to worm its way in every direction under the skin and to produce much destruction of parts. Moreover the matter from the ulcer readily produces other ulcers on the same person. This sore appears first simply as a small red inflamed area, where the poison has penetrated. In two or three days it is a pimple and the skin around it is inflamed. In another day it is a bleb filled with clear fluid, which, however, becomes yellow; and when about the sixth day the pustule bursts, the ulcer is the result. It is capable of invading the tissues in every direction and producing extensive loss of substance. There is often considerable surrounding inflammation and pain. Moreover, some of the matter from the ulcer may be picked up by absorbent vessels and carried to the chain of glands in the groin (*d, e, f,* Fig. 113, p. 208), leading to the inflammation and suppuration of one or more of the glands. This is called a **bubo.** If it actually comes to matter, and is allowed to take its course and burst, then a large ragged foul sore is produced, pouring out a profuse discharge, and the matter of this ulcer is capable of producing a new one on parts with which it comes into contact, just as the matter of the original sore. It is, if not promptly and vigorously treated, almost certain to spread along the groin, invading one gland after another, till a large irregular ulcer is produced. Even although material is not carried up to the glands of the groin infecting them, a bubo may arise owing merely to the irritation. This is called a **sympathetic bubo.** It is simpler and more easily dealt with than the former, but may end in the formation of an abscess. The indications of the formation of a bubo are redness, heat, pain, and swelling in the groin. When matter forms the swelling becomes soft, and it points, and soon, if not opened, bursts the skin.

The **treatment** of the soft chancre and such complications as may arise ought always to be in the hands of a surgeon. So much mischief may be produced by neglect, and so much destruction of tissue may rapidly occur, that the sooner the case is dealt with by a competent person the better. The first thing one seeks to do is to destroy the poisonous character of the sore. One of the most effectual ways is by means of strong nitric acid. The sore is wiped clean and dry with lint. A piece of lint in a basin of cold water is placed at hand, then a small piece of wood—the end of a wooden match will suit—is dipped into the acid, any hanging drop is removed against the lip of the bottle, and the piece of wood is passed over the whole surface rapidly, and excess is removed by the use of the wet lint. A white film forms immediately over the sore, due to destruction of the surface. In a day or two this falls off, leaving a healthy surface, discharging healthy matter, and showing the red granulations of a healing wound (p. 968). If the whole surface of the sore has not been touched with the acid it will remain discharging infective material and undermining the skin, reinfecting the healthy portion. It is, therefore, needful to make certain that the acid has been applied over the whole surface, the undermined edges of the skin being specially attended to. If in a day or so the sore seems extending in some directions and healing in others, one may conclude that the application of the acid has not been thorough enough, and it may then be reapplied. Instead of nitric acid carbolic acid might be used.

After the excess of acid has been removed by the wet lint the part should be dried, iodoform should be dusted over it, and a piece of antiseptic cotton lightly fixed upon it. Twice a day, at any rate, the dressing should be removed, the part carefully washed with hot water, dried, and fresh iodoform and dressing reapplied. Carbolic lotion or chloride of zinc lotion might be used instead of the iodoform, or sulpho-carbolate of zinc lotion (see Section IX., p. 910), the strong penetrating smell of iodoform is so unpleasant. If any of these is used a pledget of lint is soaked in it, placed over the sore, covered with oiled silk, then with a larger piece of antiseptic wool and lightly secured with a bandage.

It should be noted that scrupulous care must be exercised in washing the hands after performing such a dressing, and in burning all particles of lint, cotton, &c., that have been used. No towels should be employed, but only pieces of lint, &c., that can readily be burned. All this is to prevent infection of others.

When a bubo is threatened the person should immediately take up a reclining position and keep at perfect rest, since motion only aggravates the pain and swelling. Then cloths, lightly wrung out of iced water, should be placed over the part and renewed every few minutes for half an hour or so on end. After two or three hours' interval this process may be repeated. If the pain and swelling begin to subside, this treatment should be persevered in, the ice, however, never being so long applied continuously as to produce a livid appearance on the part. If, however, the swelling increases and becomes soft, it is clear matter has formed, or is forming, the ice is to be abandoned and warm applications employed. At the very earliest moment the abscess should be opened, for if this be not done the matter may burrow in all directions and effect much destruction. If the abscess be a simple one it is enough to keep it clean by frequent bathing and to apply simple dressings of some antiseptic solution and antiseptic cotton. If, however, it is an abscess produced by absorption of the poison of the original sore, it will, like it, exhibit highly destructive tendencies, and will require to be treated on the same lines as the original chancre.

Throughout all this treatment the person should take light opening medicines of the saline kind (p. 862). should have a plain but wholesome and nourishing diet, and should avoid all spirituous liquors. Complete rest is almost a necessity.

Urethritis or **Gonorrhœa** is an inflammation of the urinary passage, which may be occasioned by mechanical or chemical irritation, the passing of a catheter or stone, by contact with discharges of a perfectly innocent character, such as that of leucorrhœa (the whites), but which is most commonly due to impurity. But the fact that it may arise in a perfectly innocent way must never be overlooked. In cases due to contagion the first symptoms occur in four or five days, though they may arise sooner or later. They consist in a feeling of itching at the orifice of the canal, a feeling of heat or slight scalding in passing water, a slight thin discharge, and some degree of redness and pouting at the opening of the canal. Within twenty-four or forty-eight hours acute inflammation has developed, the redness and swelling are much increased, the scalding is great, the discharge is copious and white or yellowish white, and there may be frequent desire to pass water, only small quantities coming with difficulty and with much pain. Painful erections (**Chordee**) occur specially during the night. This condition of affairs lasts for several days, or for fully a week, and then the symptoms begin to abate. The pain, &c., diminishes and disappears, and the discharge becomes thin and watery and scanty, and may speedily cease. A thin and scanty discharge may, however, persist for a long period—termed a **Gleet**. There are numerous complications which may occur. Inflammation may extend to the testicle or bladder, and very commonly to one of the glands of the groin, ending in a bubo (see p. 987), which, however, is more easily subdued than that due to soft chancre. Two other complications of gonorrhœa are gonorrhœal rheumatism and an inflammation of the eyes, exactly resembling that described on p. 458 as purulent inflammation of the eyes of the newly born. The treatment of gonorrhœa to be successful depends upon so many details, if it is speedily to effect the cure of the inflammation and prevent it becoming chronic, that it is hardly possible for it to be treated successfully except by a skilled person. The general lines of treatment may, however, be indicated. First of all physical exertion should be avoided, absolutely if possible; the bowels should be unloaded by a brisk saline medicine, such as salts or seidlitz-powder; the diet should consist of skimmed milk as largely as may be, at any rate all fat, highly seasoned dishes, pastries, pepper, acid substances and fruits being carefully refused, and very specially all alcoholic drinks whatever being denied. Abundance of soda or potash water, apollinaris, or seltzer, may be drunk alone or with milk, as well as ordinary water. These dilute the urine and diminish its irritating characters. To still further diminish the acidity of the urine, to increase the quantity of water passed in order to flush the canal, and to relieve pain, the following mixture is taken in table-spoonful doses every two hours:—

Bromide of potassium,...............	160 grains.
Acetate of potassium, ...	4 drachms.
Infusion of pareira brava, or infusion of buchu,......................	8 ounces.

Mix.

If the pain and chordee are great, 4 drops of tincture of belladonna may be added to each alternate dose. The part should be kept perfectly clean, but not enveloped in a mass of material, a thin layer of absorbent cotton only being used to absorb the discharge, and fixed by being lightly rolled round the point of the organ and secured by the foreskin being drawn forwards over it. It must be frequently renewed. If the chordee be severe, full doses of bromide of potassium—30 grains in each dose—should be given several times during the day, and along with 5 to 8 drops of tincture of belladonna at bed-time. A morphia suppository ($\frac{1}{2}$ grain) may be passed up into the bowel at bed-time. If so, however, care must be taken to secure free movement of the bowels by a seidlitz-powder early next morning. In many cases the symptoms subside without further treatment. Should they not disappear, but the disease pass through all its stages, injections need to be resorted to, but they are not to be employed during the inflammatory process, but only after the inflammatory symptoms have declined, after the first eight or ten days. When this stage is reached, the simplest injection is that of sulphate of zinc, 2 grains to each ounce. It is at this stage also that, for the first mixture, one containing cubebs and copaiba is substituted. Perhaps the simplest form is that of capsules containing 20 drops each of oil of cubebs and copaiba, of which two to four are taken three or four times daily, or instead 10 drops of sandal-wood oil on a piece of sugar three or four times daily, or 20 drops of copaiba with 20 of liquor potassæ and an ounce and a half of water may be taken thrice daily. Such treatment ought to be sufficient to effect a cure; but it must be remembered that a modified form of the inflammation may readily recur with a slight exciting cause, and great care and moderation in eating, drinking, and in other habits will be necessary to confirm the cure. The manner of giving the injection is of the utmost importance, since unless the injection fluid be brought into contact with all of the inflamed membrane of the canal no benefit can be expected. The patient should have a glass syringe, capable of holding one ounce. It should be provided with a bulbous end. When the syringe has been completely filled with the injection fluid and all air expelled, the bulbous end is introduced into the canal, the organ being held upright with the left fore-finger and thumb. The mouth of the canal is pressed against the syringe to prevent any fluid escaping; and the piston of the syringe is slowly pressed down till the canal is full. When the syringe is withdrawn the person must compress the mouth of the canal with finger and thumb for two or three minutes, to retain the fluid. When the person lets go, the fluid is immediately ejected by the elasticity of the canal. Before the injection is given the patient should pass water to wash any matter out of the canal, and prevent it being driven up into the bladder by the injection. Instead of the sulphate of zinc, sulpho-carbolate of zinc may be used in solution, 1 grain to each ounce of water, or Goulard's water. Chronic forms of the disease it is needless to consider here, nor yet cases of gonorrhœal rheumatism or ophthalmia, which must have expert treatment. Complete rest and the use of saline opening medicines and the application of iced cloths, as suggested on p. 988, will often arrest a threatened bubo or inflammation of the testicle. In the latter case a suspensory bandage to relieve the parts of dragging is essential.

Section III.

SHOCK OR COLLAPSE AND SYNCOPE OR FAINTING AND INSENSIBILITY: THEIR TREATMENT. THE TEMPORARY TREATMENT OF FRACTURES. THE CARRIAGE OF INJURED PERSONS.

- Shock or Collapse:
  - *Its Nature and Treatment*—Syncope or Fainting;
  - *Reaction and Traumatic Fever;*
  - *Insensibility or Unconsciousness.*
- The Temporary Treatment of Fractures:
  - *The General Signs of Fracture;*
  - *Temporary Treatment of Broken Collar-bone;*
  - *Temporary Treatment of Broken Upper Arm;*
  - *Temporary Treatment of Broken Forearm;*
  - *Temporary Treatment of Broken Thigh-bone;*
  - *Temporary Treatment of Broken Lower Leg;*
  - *Temporary Treatment of Broken Ribs;*
  - *Temporary Treatment of Broken Jaw-bone.*
- The Carriage of Injured Persons:
  - *A Two-handed Seat;*
  - *A Three-handed Seat;*
  - *A Four-handed Seat*—Queen's Chair;
  - *The Use of Forms, Garden Chairs, Settees, &c., for Transport;*
  - *Rifle and Blanket Stretcher;*
  - *How One Person may Carry an Unconscious Individual.*

SHOCK OR COLLAPSE, AND SYNCOPE: THEIR TREATMENT.

Shock is a state of depression of all the vital powers, following upon some injury or marked mental or emotional impression. The degree and duration of shock are very various, being dependent not only upon the severity of the injury or impression, but also upon the vigour and susceptibility to nervous impressions of the individual. Thus a sudden injury may produce such a profound and paralysing influence upon all the vital powers that death may occur almost immediately or after a brief period. For example, a sudden blow on the pit of the stomach may cause death, due to shock, and after an extensive burn death may occur from collapse in spite of efforts to produce a rally by means of stimulants, &c. On the other hand, an individual may suffer from slight and passing shock, owing, for example, to the receipt of sudden tidings, either joyful or painful, or owing to some slight injury or sudden pain. To take this last instance first, most people know what are its signs—the sudden blanching of the face, the appearance of confusion, the tottering gait, the clutching at a support or sinking into a chair, the trembling that seizes the whole body, the coldness of the hands, indeed of the whole body, the cold clammy sweat that bathes the surface, the sickness, perhaps, and faintness. After a few minutes of anxiety, there is often a prolonged sigh as if some heavy load were being removed, and the colour begins to return; the person begins to rouse himself; and it may be that the momentary depression passes into a brief period of reaction, during which the person's face becomes suffused with a bright flush, and the skin becomes warm and moist. When the shock is more severe, the pallor of the skin remains; the hands and feet are specially cold; the pulse is feeble but quick, sometimes scarcely perceptible at the wrist; the breathing is slow, shallow, and sighing; and the person, though conscious, lies still, with dull eyes, but a strained look upon the face, replies weakly and with effort to any questions, and is, as a rule, entirely indisposed to make any effort either in moving or speaking, while there are indistinctness of vision and confusion of thought. Vomiting may occur and the patient begin to recover, as evidenced by the strengthening of the pulse, the increase in the breathing, the return of blood to the skin and its consequent warmth and moisture. During the period of shock the temperature is invariably below the normal, from a half degree to one and a half or more, and the depression of the temperature is a very good guide to the degree of the shock. If the depression increases, instead of diminishing, all these symptoms become aggravated, the prostration is more marked, weak quick pulse, feeble imperceptible breathing, and anxious only semi-conscious look upon the countenance; while the pupils are usually dilated, and motions are passed involuntarily from the bowels. Spasmodic muscular twitchings often occur. If, however, the shock is passing off, there are gradual improvement of pulse and breathing, gradual restoration of colour and animation to the face, and gradual restoration of warmth to the surface. The state of depression over, the person passes into a state of **reaction**, with full bounding pulse, quickened breathing, flushed and moist skin, and elevated temperature. This reaction stage usually corresponds, though not always, in duration and degree with the preceding depression. The more severe and prolonged the collapse has been, the more pronounced will be the after reaction. Commonly, however, its signs do not pass much beyond the activity of the normal healthy standard. But after injury or operation it may be so well marked as to become an actually feverish condition; thirst, loss of appetite, foul tongue, constipation, scanty high-coloured urine, excitement and loss of sleep, indicating general disturbance of the functions of the various organs. When reaction goes to this extent, the term **traumatic fever** is applied to it.

In some cases of shock, the patient, instead of being motionless and listless, is restless and excited, tossing about in bed, throwing the arms from side to side and moving the head, in an apparent state of great mental distress. At the same time the other signs of lowered vital powers are to be found, namely pallor, weak pulse, and feeble breathing.

The state of collapse which has been described is usually most severe after injuries involving considerable injury to the tissues or covering an extensive surface. Thus in extensive burns, it is the collapse that is dreaded to begin with rather than the actual injury itself; and it is a most marked feature of injuries accompanied by considerable bruising or crushing of parts, or injuries to bones or joints. The restless form is witnessed when there has been considerable loss of blood, or where there is much pain. Usually, however, in the state of collapse the sensations are much blunted and the patient is not acutely sensible to pain, even sharp pain, but only vaguely conscious of it.

A person may remain in a state of shock for a variable time, from a few minutes to several hours, and this depends not only upon the severity of the injury but also upon the state of the person. For example even trifling accidents produce severe symptoms of shock in persons subject to kidney disease, while women and children and persons of a nervous temperament have rapid and sharp reaction, followed by speedy recovery.

The causes of these symptoms that have been described are no doubt to be referred to the nervous system. In the case of death following a blow on the stomach the fatal result is due to the powerful impression made upon a large mass of nervous substance, called the solar plexus, and connected with the sympathetic system of nerves (see p. 98), which is situated behind the stomach. It is the duty of this system of nerves to preside over the animal functions, the distribution of blood, the action of the heart, the work of the digestive organs, and so on; and any profound impression upon these nerves necessarily affects in a most marked way all these processes. When one, then, considers that it is the effect produced on the nervous system which results in the production of the symptoms that have been described, one can understand how such different things as a sudden joyful surprise, a piece of bad news, a sudden fright, an unlooked-for appearance, or a fall or other injury, may all produce similar effects. The feeble heart, the faint breathing, the cold skin, the vacant mind, the lessened sensibility to pain, are all evidences of unequal and irregular distribution of blood and faint stimulation of the heart, the result of weakened or semi-paralysed nervous influence.

Syncope is a condition akin to shock in its nature and cause. It is sudden and profound and caused by arrest of the heart's action. It may occur because of sudden emotion or fright, or because of pain, or loss of blood. It has been already described on p. 243.

The Treatment of Shock.—In the very slight cases of shock little or no treatment is required. The person should be made to sit down or recline, and the application of smelling-salts to the nostrils, the administration of a tea-spoonful of aromatic spirits of ammonia (sal volatile) in water, or any hot drink, will usually be sufficient. This is practically the same treatment as has been already described for fainting on p. 243. In the case of severe shock, however, much more is necessary. A consideration of the real nature of the attack will clearly show that the two chief objects to be sought in treatment are the restoration of the warmth of the body and of the activity of the circulation. Both of these objects are obtained by the same treatment. The person is to be laid on a bed or couch and the clothes are to be quickly removed, the usual night garments being substituted. Hot-water bottles should be placed at the feet, or hot bricks wrapped up in flannel. It is needful to warn against placing a bottle filled with boiling water against the patient's body unprotected from excessive heat. For, in the state of diminished sensibility of the patient, actual burning of the skin might occur without the person experiencing pain. A very severe case of this sort came once under the author's treatment. If the coldness of the body is extreme and the prostration great, the patient may be wholly wrapped in warm blankets, and hot-water bottles placed outside the blankets to maintain their warmth. In such extreme cases, also, flannels wrung out of hot mustard and water (a table-spoonful of mustard to a pint of hot water) should be placed over the chest and belly, and specially over the heart, and these may be frequently renewed. Or a mustard poultice may be applied, or a cloth sprinkled with turpentine and then covered over with a thick flannel pad wrung out of hot water. Meanwhile, any assistants may be occupied rubbing the limbs from their extremity upwards. This should be done without exposing the parts to further cold. In the next place stimulants are to be given by the mouth, if the person can swallow. Whisky or brandy in hot water is undoubtedly the best. Two or three tea-spoonfuls of the spirit in half a wine-glassful of hot water may be given at once, and this may be repeated in twenty minutes or half an hour, if needful. It may be repeated at brief intervals several times, the pulse being taken as an indication of its need; but excitable people are apt to administer large quantities in their terrified zeal; and this must be guarded against. Strong hot coffee or tea is also useful if an alcoholic stimulant be not at hand. Instead of any of these, ammonia, either in the form of the weak spirit of hartshorn (10 to 15 drops in water) or in the form of the aromatic spirit (half to one tea-spoonful in water), may be given by the mouth and frequently repeated. Small quantities of hot beef-tea—a wine-glassful at a time—are also useful, frequently repeated. If the person cannot swallow, the stimulant—whether of whisky and water or milk, brandy and water or milk, or wine and water, or ammonia and water—should be injected into the bowel. Severe cases of shock, and the shock of snake bite, have been treated successfully by the injection *into a vein* of 10 drops of the spirit of hartshorn in 1 or 2 ounces of warm water. This could only be undertaken by a medical man, but the same quantities could be injected into the bowel without risk by anyone. Ether—sulphuric ether—is often employed to produce a rally in profound prostration after injury or loss of blood—10 to 30 drops may be injected under the skin by means of the hypodermic syringe. It acts with great rapidity. All these measures are not necessary except in most extreme cases. In ordinary cases, in which the circulation is restored in from half an hour to two or three hours, the warmth to the body, friction, and the hot stimulant are quite sufficient. Provided the pulse is gradually improving it is a mistake to be too officious. Someone requires to "stand by," and give occasionally another small dose of the stimulant, for in such cases the patient is quite conscious and able to swallow. By being too energetic one is apt to encourage an excessive reaction and some amount of fever. Should such undue reaction occur iced cloths may be applied to the head, stimulants are to be stopped, diet is to be kept low, and, if necessary, a dose of purgative medicine may be given, 5 grains of calomel followed by castor-oil or a dessert-spoonful of some saline medicine such as granular effervescing citrate of magnesia.

It is to be remembered that sometimes, after a patient has begun to rally, a relapse occurs. Therefore he is to be watched carefully. As soon as the pulse, breathing, and colour are improved, stimulants should be given less frequently, but watchfulness exercised so that on the slightest appearance of renewed depression an additional quantity might be given.

The treatment of shock accompanied by restlessness is to be conducted on the same lines, for the restlessness and excitement are indicative of great weakness to be met by stimulating drinks and nourishment.

Insensibility or **Unconsciousness** may arise from many causes, from concussion of the brain (p. 104) as the result of a fall or a blow, from shock (p. 990), from an epileptic (p. 123) or apoplectic (p. 103) fit, from fainting (p. 243), from poisoning by alcohol (p.1024) or opium (p.1025). The symptoms of these conditions have been already described in the paragraphs already referred to and the appropriate treatment stated. Great and sudden loss of blood will also cause deep unconsciousness. The surroundings will often indicate clearly the nature of the case. It may be evident from the situation and position of the body that the person has fallen from a height; the presence of wounds will assist the formation of an opinion. If the unconsciousness is due to loss of blood from a wound, or a ruptured varicose vein, this will usually be evident. The features of apoplexy (see p. 103) are easily distinguished from shock or fainting.

In all cases lay the patient on his back, the head slightly supported; have him under cover; remove all tight clothing; arrest any bleeding; restore and maintain the heat of the body by friction and warm applications. In cases of shock, fainting, loss of blood, stimulants are necessary. But in apoplectic seizures, concussion of the brain, and epilepsy, efforts to restore consciousness and the use of stimulants are hurtful. Alcohol and opium poisoning are spoken of elsewhere.

THE TEMPORARY TREATMENT OF FRACTURES.

Fractures have been considered at length on p. 35 and the following pages, and the causes, varieties, symptoms, and treatment of them have been detailed at length. In this part, devoted to accidents and emergencies, however, it is thought advisable to make a brief summary of the means by which the fact that a bone has been broken may be determined quickly in the cricket, football, or hunting field, and to explain how, without any of the special appliances described in the pages referred to, such accidents may be temporarily treated, so that additional injury may not be inflicted before surgical aid arrives, or in course of conveying the person within reach of it.

Such information is of the utmost value to all engaged in out-door sports and to many others besides, and ought to be in the possession of everyone. Such an injury may be readily sustained, and often is so, by even a simple jump from a style, by a fall, by a kick, by a fall from a horse. In the most of these cases the injury is comparatively simple, the damage done is not extensive, and if the broken bone were, then and there, properly secured till it could be treated by a surgeon, comparatively rapid recovery would be made. But very often much more extensive damage is inflicted than that due to the original accident, because of the want of knowledge of how to handle the limb on the part of those who come to the aid of the injured man. Too often a patient, who has suffered a break of one of the bones of the lower leg, is encouraged to make repeated attempts at walking, supported on each side, or is roughly and unskilfully carried to some shelter, the injured limb being permitted to dangle and twist, to the grievous injury of the soft parts. A simple fracture is often thus converted into a compound one by the ends of the broken bone being thrust through the soft parts, or by its movement vessels are torn and nerves injured, and a simple injury converted into one of great extent and gravity, while inflammation is excited and much pain inflicted. All this a little knowledge would render impossible. No harm is done if a limb is supposed to be broken, the bone of which has really suffered no such injury, and if under the mistaken notion the temporary treatment for a broken bone be adopted, while great injury and suffering may be the result of mistaking a fracture for a dislocation or of failure to think of the possibility of fracture at all.

The General Signs of Fracture will be briefly stated. They are noted in detail on p. 36. The first is immediate disablement. If the leg be broken the person falls to the ground, and if he attempts to rise it is only to fall again. The broken arm falls by the side. When the collar-bone is broken the shoulder drops and cannot be raised by the person himself. Then the limb is more easily moved than its fellow; it bends at the break, unless in the case of the lower leg or forearm, when only one of the two bones is broken and the other acts as a splint. On pressing with the thumbs at the seat of injury the two ends of the bone yield and a grating feeling may be experienced. Usually deformity is produced by the muscles acting on one or other of the parts of the bone; thus, in the case of the thigh, the limb is shortened and turned out, and so on.

We shall notice the more common fractures separately and indicate how they are to be temporarily adjusted, the directions given being in every case fully illustrated in Plate XV.

Temporary Treatment of Fractured Collar-bone.—In this case the dropped shoulder, which the person cannot raise by action of the muscles, the ends of the broken bone projecting under the skin at the upper part of the chest, and their mobility and grating, indicate the nature of the accident. A firm pad is to be made, which can be improvised of pocket handkerchiefs, a soft cap, a waistcoat rolled up, or for that matter a bundle of hay rolled up in a handkerchief; and it is to be placed well up into the arm-pit to raise the shoulder. If the person applying the pad will grasp the upper arm, high up, with the left hand, and raise the shoulder, bracing it back at the same time, and then push up the pad, the replacement will be effected. The forearm is to be bent and folded over the chest, and kept in that position till a bandage is passed round the chest—a triangular bandage, or a handkerchief or a neckerchief, or if nothing else is to be had a belt or a brace—to fix it there. Lastly the arm is to be supported in a large sling, the elbow being well held up. (See fig. in Plate XV.)

Temporary Treatment of Broken Upper Arm.—Here the position in which the person holds the arm is significant. He supports the elbow by the hand of the uninjured side, holding it close to his side. The mobility of the upper arm, the shortening produced, the irregular hollow felt on passing the hand down from the shoulder, whose roundness is maintained, all indicate at once what is wrong. The ragged ends may readily be felt even through a coat sleeve. It is not necessary to remove any clothing, in fact inadvisable, for every disturbance except by a skilled person is apt to be hurtful. Let the forearm be bent and held over the chest, let the person assisting put a narrow sling round the neck, supporting the wrist but *not the elbow* (see Plate XV). That done, let him look for something to act as a splint. A piece of paling may suit, or a pair of hunting whips (see Plate XV.), or a walking-stick broken in two. Something should be wrapped round the temporary splints to protect the arm from undue pressure. One piece is to be placed on the front and another on the outer side, and inside it will be well to place a pad, which a folded waistcoat will readily supply. Then let something to fix them with be looked for, handkerchiefs, neckties, braces. In the case of the hunting whips, the whip ends might do in the absence of everything else. Let all be got ready to save unnecessary handling of the arm. Then place the splints in position on the front and outer side of the arm and the pad on the inner side, *take care that the pad does not press too far up into the arm-pit to hinder the circulation*, and place the straps ready to be tightened. Then let one person firmly grasp the arm above the elbow and pull gently but steadily downwards. The displaced ends of bone will readily be brought opposite one another, and then the straps are firmly secured to keep them so. If only one person be present beside the injured man, it will be necessary for him to apply the splints and partially tighten the bandages before pulling on the limb, in order that when the arm is pulled down he may be able to complete the tightening with one hand, while he holds the arm in extension with the other. By having the sling on previously his task will be easier. If two persons are present to assist, one will keep the fragments together while the other adjusts the splints and bandages.

Temporary Treatment of Broken Forearm.—If only one of the two bones of the forearm (see Plate I.) be broken, temporary treatment is very simple. It is only necessary to place the arm in a broad sling, without disturbing any clothing or applying any splint, for the unbroken bone acts as a splint. That such a break has occurred is discovered by passing the thumbs one after the other along first one side of the forearm and then the other. When the break is reached, pain is complained of by the person, the bones are perceived to yield, and grating is felt by the person assisting. If both bones be broken, the forearm yields completely at the break and deformity is produced. Here again two pieces of paling, the two halves of a broken walking-stick, &c., are to be procured. If such a narrow piece of wood as a stick affords is all that is to be had, it is better to roll it up in a waistcoat or anything else which will give it some breadth and prevent it pressing unduly on one part of the forearm only. If the injured person has his coat on, it should not be removed; if he happens to be at the time coatless some soft padding *must* be interposed between the arm and the extemporized splints. Bend the forearm and carry it across the chest, thumb directed upwards. Apply the padded splints so that one lies along the front of the forearm, projecting out beyond the elbow behind, *not pressing into the elbow*, while the other lies along the outer side, and secure with one or two straps, which handkerchiefs, neck-ties, garters, &c., will provide. If both bones are broken it is necessary before applying the splints to grasp the hand, and, the elbow being fixed, gently to pull on it to reduce displacement and bring the broken ends opposite one another, in which position the forearm must be fixed. This is not necessary if only one bone is broken, since the sound bone prevents displacement as a rule. Then support the forearm in a sling, the broad sling will be best though the narrow one is represented in Plate XV.

Temporary Treatment of Broken Thigh-bone.—This accident is recognized by the fact that the person cannot use the limb, which is shortened and turned outwards, so that as the person lies on the ground the heel of the uninjured limb rests on the ground while the foot of the broken leg lies on its *outer side*. It is quite unnecessary to remove any clothing, to cut up the trousers, or disturb the clothing in any way. Let the foot of the injured leg be taken by one person, the heel resting in the palm of the left hand and the other hand over the back of the boot, and let that person gently pull on the foot, turning it into its correct position, so that the heel is directed downwards and the toes upwards; let him bring it alongside its fellow, pulling on it so that the two limbs are of the same length. Meanwhile let another make a pad by rolling up a jacket lengthways, or other suitable material, and place it between the two thighs, extending pretty well up, and down beyond the knee at all events. Then let a splint be found. If only one person is present to assist the injured man, he may insert the pad between the thighs then draw on the foot, and tie both limbs together at the ankle by means of a handkerchief, thereafter going to find a splint. The splint must be long enough to reach nearly up to the arm-pit and down to project beyond the feet. Again a piece of wood torn from a paling might suit. In Plate XV., one figure shows how a rifle might be used, the stock resting up near the arm-pit and the barrel passing down the leg. Let it be noted that the barrel should not be allowed to rest on the ground but should pass *along the middle of the leg*. In the case of the rifle or anything so thin, a pad to surround it and so increase its breadth would be a great advantage. The extemporized splint being applied is to be fixed by several triangular bandages, handkerchiefs, or the like, which are to secure, not only the splint on the outside but also the pad on the inside. Finally a strap is to be passed round the body and the upper end of the splint, and another binds both legs together. Thus one leg acts as a splint on the inner side of the other.

After this has been done, as the person will be compelled to lie flat on the ground till means are provided for his removal, those assisting him should see that he is protected as far as possible from damp on the ground by coats, &c., gently passed under him, or he may at once be carried to drier ground if four persons be present, by the method described in the section dealing with stretchers. Three persons kneel down on the left knee on one side of him, one at the head and shoulders, another opposite the hips, a third at the lower legs, while the fourth kneels down on the other side, opposite the middle of the three. All four insinuate their arms under him and all acting together rise as one man, and slowly carry him off. In laying him down again they must be careful again all to act together.

Temporary Treatment of Broken Lower Leg.—The treatment of this accident is quite similar to that of broken forearm and is usually easy, since commonly only one of the two bones of the lower leg is broken, though, of course, both may suffer. In the case of only one being broken, though the person cannot walk or support himself on that leg, there is no displacement, the sound bone acting as a splint. But on passing the fingers along the outer and then the inner side of the leg, a place is reached where pain is complained of, the bones are found to yield and grating is felt. Again it is quite unnecessary to cut up the trousers or remove any part of the clothing. A splint is wanted for the outside of the limb, and, if it can be obtained, for the inside also. Plate XV. shows how two bayonets might be used, or the scabbard of a short sword. In the case of the bayonets it would be necessary to protect the leg from their sharp edges by enveloping them in some thick material which would act as a pad. Whenever possible the extemporized splint should be made to project beyond the foot and should be broad enough there to prevent the foot moving from side to side. Plate XV. shows a cricket bat applied for such a purpose. The splints being padded and applied, one outside and the other inside, they are to be secured by three fastenings at least. If only one splint is available place it outside and put a pad inside. It will be an additional protection to the injured limb, if the two legs be then bound together near the ankles and knees.

Temporary Treatment of Broken Ribs.—The danger of a broken rib or of broken ribs is that, in the carriage of the person, or in his own walking for help, the movement causes one of the broken ends to puncture the lung or do other similar damage. This is the more likely to happen the farther round towards the back the fracture happens to be. Short difficult breathing accompanied by pain, following a fall or blow or squeeze, should lead one to suspect this accident. The person usually carries himself also in a particular way, leaning over to the injured side, and keeping his arm close against it to restrain movement. This is the object of temporary treatment, and is quickly applied by passing a stout *broad* bandage round the chest and fixing it firmly. A shawl might be folded along its length to an appropriate amount, and wound firmly round the body for this purpose, being fixed by pins.

Temporary Treatment of Broken Lower Jaw may be applied by means of an ordinary handkerchief of sufficient length by tearing it into a four-tailed bandage (p. 959). It is torn down the middle from each end to within 3 inches of the centre. The centre is placed over the chin, the lower tails carried up the side of the head and tied on the top and the upper ones to the back of the head, being tied there. Refer to p. 959.

THE CARRIAGE OF INJURED PERSONS.

Of equal importance with the appropriate temporary treatment of injured persons, specially such as have had the misfortune to get a bone broken, is their skilful conveyance to shelter or assistance. Fractures can hardly be put up, however skilfully, so as to render it difficult to do serious injury in transporting the person from one place to another, and any simple means which will lessen the chances of further harm is worth noting. Two persons alone may carry an injured man for a considerable distance without any appliance at all, if he can assume a sitting posture, by forming a two, three, or four handed seat.

A Two-handed Seat is formed by the two carriers standing in line, making a quarter turn towards one another, and locking their hands together by the fingers, palms upwards, the right hand of the right-hand man locking with the left hand of the left-hand man, the other hand of each resting on the shoulder of the other (see fig. 3, Plate XIV.). The locked hands form the seat and support the patient under the thigh-bones a little above the knees, while the other arms support the patient's back. The patient may be able to assist by putting an arm round the shoulder of each bearer.

A Three-handed Seat is formed by the carrier on the right grasping his left forearm above the wrist with the right hand. He then grasps the left forearm of the left-hand bearer, whose left hand grasps the right wrist of his neighbour (fig. 4, Plate XIV.). The left-hand bearer's free right hand is laid on his neighbour's shoulder. The joined arms thus form a triangular seat, and the left-hand bearer's right arm supports the patient's back.

A Four-handed Seat is used when the patient is able to support himself in the sitting position by placing his arms round his bearers' shoulders. Each bearer grasps his own right forearm, near the wrist, with his left hand, and with his free hand grasps his neighbour's left forearm (fig. 5, Plate XIV.). This is called a "Queen's Chair."

Chairs.—A person who may be carried in a sitting posture may be transported in a chair, a high-backed chair if his head and shoulders need support, or an ordinary chair, if he can maintain his sitting posture unaided by a support to his back. A rocking-chair may be utilized for the purpose by passing two stout long sticks, fully longer than broomsticks, under the chair, one on each side, and tying them. The staves should slope downwards from back to front, passing close under the seat at the back and being tied at the junction of the seat and the uprights of the back, and passing *under* the lower round in front, and securing each at the junction of the round and the front upright of its own side. A bearer in front and one behind, standing between the trams thus formed, will easily carry the chair, as the old-fashioned sedan-chair used to be carried. A person with broken ribs should thus be carried in the sitting position, or by a two or three handed seat.

School Forms, Settees, Garden Seats, &c., may be utilized for those who must be transported lying at full length, as in cases of broken thigh-bone, as illustrated in fig. 2, Plate XIV. Such a seat could be carried by hand by four bearers, if a stout stave were passed under the seat at each end in a direction across its length, so that it projected at each side.

Rifle and Blanket Stretcher.—A stretcher may be improvised by means of two rifles and a blanket as shown in fig. 1, Plate XIV. The rug or blanket is fully unrolled. Under each of the two sides a rifle is placed, and the rug is firmly rolled in round the rifle, till the space between the two rifles is reduced to 20 inches. An improvised stretcher may be made of a blanket and rug and four stout poles; rake handles would be suitable. Two long poles are placed on the ground parallel to one another, 18 to 20 inches apart. Near their ends they are crossed by two of shorter length. The poles are firmly tied with whip-cord where they cross one another. The blanket, rug, or sheet is then fastened on, specially well down the sides and at the angles where the poles cross.

Stretchers and Stretcher Drill are considered in detail in a succeeding section.

Plate XIV. fig. 6 shows how by means of a bath towel an injured man, who is able to support himself in a sitting posture, may be carried up a stair with comparative ease.

When it is necessary for one man to carry another, he will do so most easily by placing himself on his patient's right side and lifting him so high that the upper part of the patient's body leans over his left shoulder, the bearer's

FIRST-AID IN ACCIDENTS.

I. This illustrates the application of splints for first-aid in a case of fracture of the lower right leg. An outer and inner splint have been applied and fixed by bandages, knotted on the outside. The legs have then been bandaged together, by one bandage passing over the ankles and another below the knees.

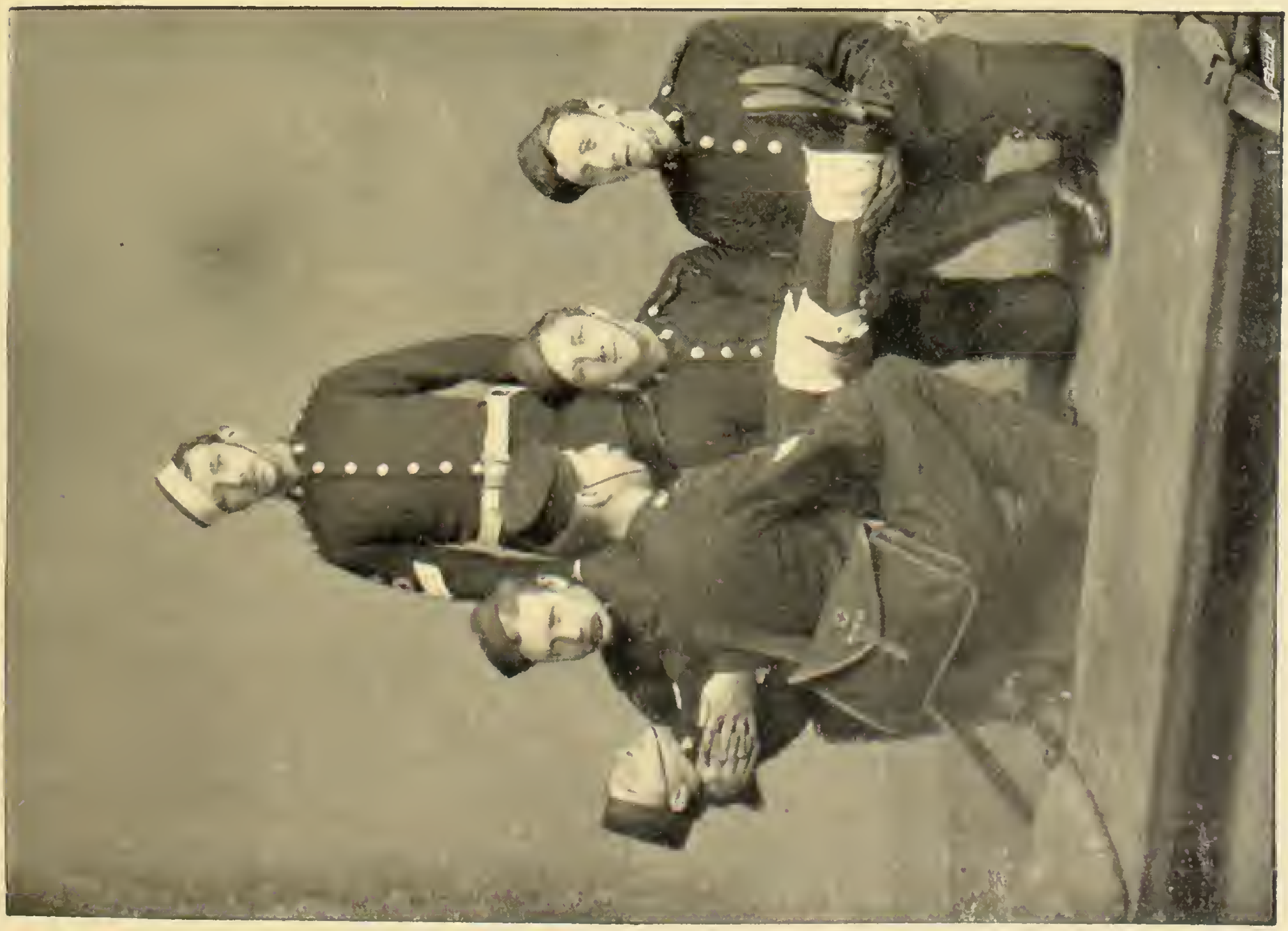
The plate also shows four men of a stretcher squad, kneeling on the left knee, lifting the patient, preparatory to placing the stretcher under him.

II. In this plate an injured man is shown with a triangular bandage applied over the head, the shoulder bandaged by a triangular bandage, and the wrist supported in a sling.

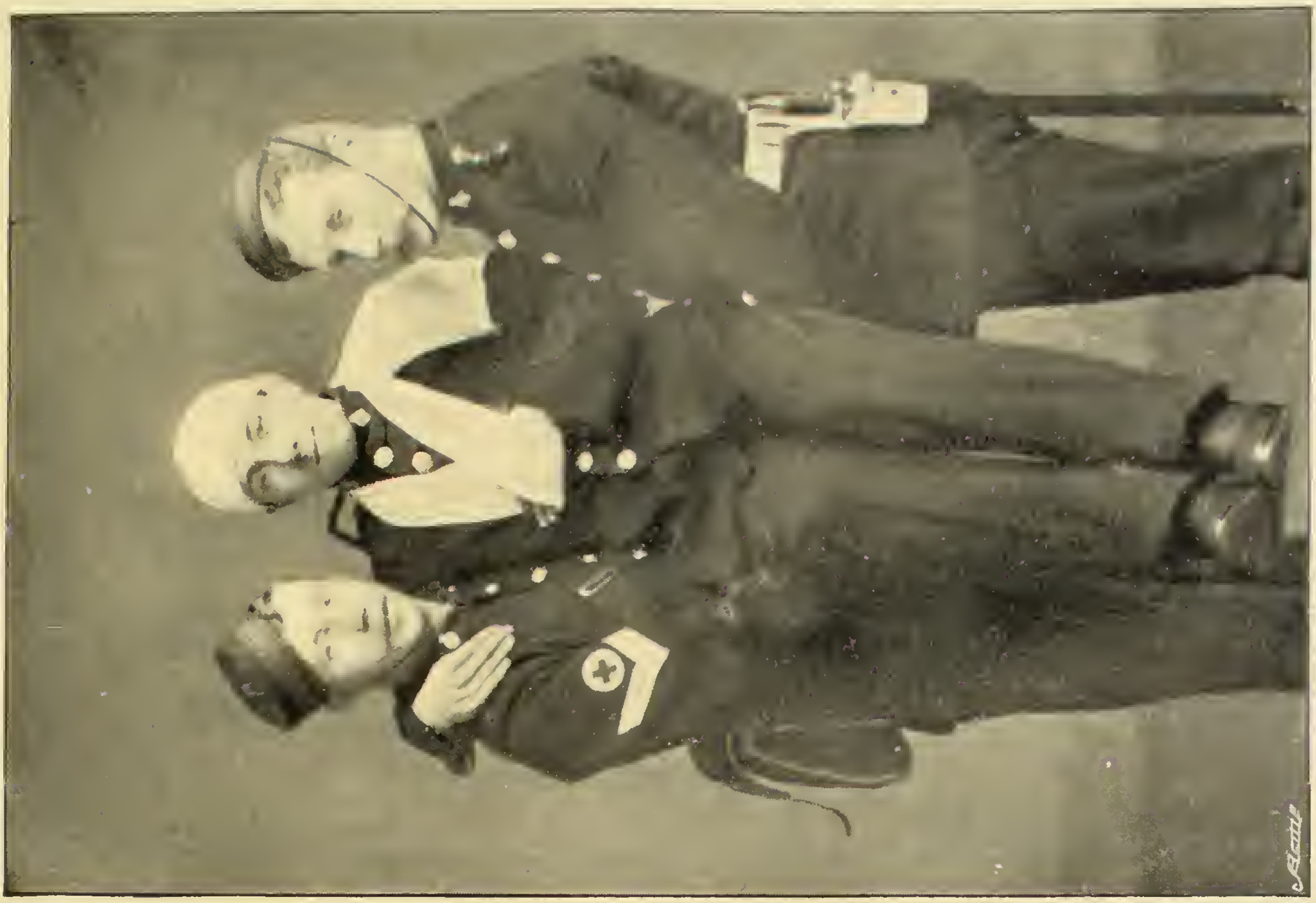
He is being carried by a two-handed seat.

15a.

Plate XVa.



I. First-aid in fracture of Lower Leg.



II. Injured Head and Shoulder, patient being carried by a two-handed seat.

left arm passing round his patient's back under his arms, and his right under his legs just above the knees. Captain E. M. Shaw, of the London Metropolitan Fire Brigade, has described another method. First turn the person face downwards, the helper standing in line with the patient and in front of his head. Let the helper then raise the person by taking hold close under his arm-pits, as high as he can, till the body rests on one of the knees. The bearer then stoops, places his arms round the patient's waist and lifts him to an upright position. Again stooping, the bearer passes one arm between the legs and round one of them, grasping with the other hand one of the patient's wrists. The person's body then falls over the helper's shoulder, and he rises with him in this position. The patient's arms are hanging over the helper's back, so that to grasp one of his wrists the arm has to be caught from behind and pulled forward under the bearer's arm. The patient is thus fixed securely on the bearer's shoulder, the hold on the leg prevents him falling backwards, and that on the wrist from slipping down.

Section IV.

THE EFFECTS OF HEAT AND COLD: BURNS AND SCALDS: SUNSTROKE AND HEAT-FEVER: LIGHTNING AND ELECTRIC STROKE: FROST-BITE AND CHILBLAINS.

First Aid in Accidents by Fire: The Extinction of Flames.
Burns and Scalds:
  Burns of the First, Second, and Third Degree;
  The Treatment of Burns and Scalds—Carron-oil;
  Burns from Explosions of Gas, Gunpowder, Burning Clothing, &c.;
  Scalds of Mouth, Throat, and Gullet;
  Burns from Chemicals;
  Burns of the Eyeball.
Sunstroke and Heat-fever.
Lightning Stroke:
  The Effects of Strong Electric Currents.
The Effects of Cold:
  Frost-bite and Chilblains.

ACCIDENTS BY FIRE: THE EXTINCTION OF FLAMES.

There is a very large amount of injury to person and property due to fire accidents, which, at the outset, were of a very insignificant and minor character. Of course, in a sense, all fires, however gigantic their ultimate proportions, are absolutely insignificant in their beginnings, just as the electric flash that fires a hundred-ton gun, or discharges a torpedo is in itself insignificant. The great fire which laid Chicago in ruins is a case in point; and the most recent illustration is furnished by the fire at a charity bazaar in Paris in this year (1897), which was due to a trifling accident with an ether lamp, and which would have done no injury to anyone but for the fact that it was surrounded by light gauzy inflammable stuff. Though the electric flash and such a lamp accident are in themselves insignificant, the surroundings, in which they occur, render their results uncontrollable from the beginning. It is not, therefore, this wide application that is meant when it is said that a very large amount of injury is done by fire accidents of very little moment at the outset. The reference is to a large class of fire accidents quite controllable at the beginning, if only there be someone in the neighbourhood who knows what to do, and is prompt in the doing of it, but which, because of the absence of knowledge and promptitude, become in a few seconds uncontrollable and disastrous. Take, for instance, the case of a pot of inflammable material, like sugar, boiling over, or like the mixture of rosin and turpentine melting over a fire to produce the preparation known to druggists as Venice turpentine. Take the case of an overturned paraffin lamp, or a window curtain set on fire by a gas bracket, or a person's clothing set on fire. In the large majority of these cases the fire can be extinguished speedily and with little damage, if instantly and properly dealt with. But too often the person presiding over the melting pot, or whose carelessness has set the curtain on fire, or overturned the lamp, loses presence of mind and rushes away to get help, and the delay, however brief, is fatal. Still more, if a woman's clothes have caught fire, is she likely in her distraction to rush about fanning the flames, when a moment's self-possession would save her. How to deal with such minor accidents should be part of the teaching of the young, just as the girl of twelve years is not now deemed too young to be taught, as part of her swimming lessons, the rescue of those in danger of drowning.

Fire cannot live without air. The process of burning is the process of rapid union of something with the oxygen of the air. If the air be cut off the fire must go out, will go out of itself. Anything which hinders the supply of air will limit the fire, and just because the union must be rapid for the production of flame the hindrance need not be complete for the extinction of the flame to be accomplished.

In the next place flame ascends. It extends more rapidly in the vertical than in the horizontal direction. A hanging curtain, therefore, will be speedily enveloped in flames above the part first set on fire, while the flame will only creep slowly along the same curtain lying on the ground. Similarly if a person's clothing has been set on fire, the flames will speedily reach the upper part of the body so long as the person remains erect, but will spread with comparative slowness if the person gets flat on the ground. Moreover, if a person whose clothes have been set on fire rushes distractedly about, she is taking the most effective means of feeding the flames with fresh supplies of air and destroying her chances of escape.

These are the two principles on which the kind of accidents now being referred to are to be dealt with. How are the principles carried into practical effect?

Let us deal, in the first place, with such accidents as an overturned lighted lamp, a pot of inflammable stuff boiling over, a burning curtain. The pot should be pulled off the fire, set down on the floor as far from the fire as possible, and, if it continue in flames, something should be thrown over it, a sack, a quilt, a coat, a rug, a table-cloth, anything close enough in texture to hinder the access of air to the burning mass, and not itself readily inflammable. The flames will be immediately extinguished. Water would be useless for such a purpose, at least in the quantity readily available. The writer has seen a large pot of flaming turpentine thus instantly extinguished without injury to anyone, and in the very midst of an apartment so full of the most inflammable material that a few minutes' delay would have involved a conflagration.

An overturned lamp should be dealt with in the same way. In this case the lamp will have rolled, and the paraffin will have run, and a flowing river of fire will have to be controlled. One is apt to try to extinguish the whole with the same rug, or shawl, or other cloth, by dragging it from one part to another of the stream. This must not be done, else the part just extinguished is almost sure to be relighted as the cloth is dragged from one place to the other. Shawl after rug, table-cloth after shawl, coat after table-cloth must be thrown on the flames, and one article not moved till the whole is extinguished.

In the case of a curtain set on fire, it must be dragged as swiftly as possible from its hangings, thrown down, and something then thrown over it, as in the other cases. But the person who is engaged with such an accident, especially if the person be a woman, cannot be too careful lest the fire spread from the curtains to her own person. In the case of a curtain the necessity for haste is not so desperate, and a moment or two of deliberate thought, as to how best to proceed to avoid the graver accident, will be well-spent time.

When a woman's clothing has caught fire, the same principles must be applied. She ought immediately to throw herself on the ground, and roll over and over, while she shouts for help. She will often be able, thus, herself to extinguish the flames without help. Even if this happy result be not so easily attained, she delays the flames reaching her face and head, which are, in such cases, the parts often most severely burned, and this delay may be her ultimate salvation. Unfortunately so many persons, in such a desperate situation, so completely lose presence of mind, that the knowledge of what ought to be done is no guarantee of its being done. The first thing, therefore, to be done by any one who rushes to help is to shout to the woman to lie down, and, if need be, to throw her down. The person who rushes to help also runs into danger. This danger is little in the case of a man, but very great in the case of a woman. Either should, on the way, seize rug or shawl, with which, in the act of being thrown down, the person may be enveloped, and by which, when she is down, the flames may be extinguished. This is not so necessary, however, for the man, whose own clothes will less readily take fire; so that, as he runs, he may simply divest himself of his coat, which he throws over the person in flames, and probably with his hands he will be able to smother out the flames from any part left uncovered.

A woman who goes to help, however, must provide herself with something by means of which she may not only envelop the person, but save her own clothes from catching fire. A blanket, shawl, table-cover, sofa-blanket, would be suitable. This she should hold in front of her, causing it to trail on the ground, for if it do not touch the ground, the flames may curl in under its lower edge and set her own clothes on fire before she has been able to render any assistance, and a new victim would be added to the flames.

If the person on fire has already thrown herself on the floor, she should be approached from the head, and the blanket allowed to fall on her from the head towards the feet, so that the flames will be extinguished from the head downwards. The rescuer, kneeling down at the sufferer's head, can then, if necessary, push the blanket down over the body towards the feet and press it close to the body and limbs, and so extinguish the flames with little risk to herself.

If the sufferer be rushing distractedly about, it is all the more necessary that the rescuer should be provided with something sufficiently large to interpose a complete barrier between the person on fire and himself, so that the rescuer may, by extending the arms, as in the act of embracing, completely envelop the person on fire, without lifting the lower edge of the enveloping material from the floor. The patient should then be thrown down, and the flames completely extinguished by pressing the covering close in to her body.

It must not be forgotten that it is the limitation of the access of air which extinguishes the flames. Whatever is used, therefore, to throw over the patient must be sufficiently thick and close in texture to achieve this result. Thin, wide-meshed stuff will not be effectual, and may only add fuel to the fire. If, therefore, the material be suited for the purpose, pressing it close to the side of the patient's body, and well down over the feet, is mainly for the purpose of preventing a current of air passing up over the person, and so fanning the flame. The close application of the wrapper to the *parts of the clothing on fire* is not, therefore, necessary, if the wrapper be large enough, and may be actually hurtful, by pressing the burnt clothing, still hot and smouldering, on to the patient's body, and so producing burns of the surface, which might, but for that pressure, have been avoided, and which may have very serious after-effects.

As soon as the flames have been extinguished, the burnt clothing should be removed from contact with the patient, being cut off carefully, and not torn off roughly, for reasons stated fully on p. 999.

THE EFFECTS OF HEAT: BURNS AND SCALDS.

There is no practical difference either in results or in treatment between a burn and a scald; the former is the result of dry heat, the contact with a heated substance, hot metal, &c., the latter is the result of contact with moist heat, hot water, steam, or hot fluid of other kinds.

There are various degrees of injury inflicted by heat, and thus a burn of the first degree is spoken of, or a burn of the second degree or of the third. The difference between these is a difference in the depth to which the injury extends, and this naturally depends on the heat of the substance which has produced the injury and on the length of time during which it was applied.

A burn of the first degree is one in which only the immediate surface of the skin is injured. The part is red, somewhat swollen, and very painful, with a stinging tingling pain, and tender to the touch. That is to say, there is a slight degree of inflammation of the skin and increased flow of blood to the injured part, but there is no blister, and no destruction of tissue, though the surface skin, the epidermis, afterwards peels off.

A burn of the second degree is one in which, owing to the severity of the injury, part of the surface layer of the skin is raised in a short time by the formation of a blister. If the fluid be allowed to escape from it, the raised skin soon dries and protects the irritated surface beneath, on which within six or eight days new epidermis is produced, and the dead dried layer separates, leaving the fresh surface sound and without scar. The pain of this degree of burn is considerably greater than the former. If the dead horny layer of the skin be removed before the new layer has formed a raw surface is left, from which matter may be given off. But soon a scab forms, under the protection of which the new layer is produced. This process may last two or three weeks.

A burn of the third degree extends through the whole depth of the skin and perhaps even into the tissues beneath. The destruction produced causes sloughing or separation of the destroyed piece of skin, and then a granulating wound (see p. 968) is left, healing with the discharge of matter like other granulating wounds. No new true skin can be produced to fill up the gap, but a scar or cicatrix is left. When such burns are extensive they cause serious deformity by their contraction and consequent pulling upon neighbouring parts. The new tissue formed to fill up the gap has never the full vitality of surrounding parts, and is always evident by its glazed appearance, its greater or less depression below the surface, its tendency to blueness with exposure to cold, and so on. The deformity produced by such extensive burns is sometimes of a very serious character. The contraction of an extensive scar of the neck and side of the head will pull the head down towards one side; that near a joint will sometimes cause permanent bending and diminished mobility of the limb. When the wound has completely healed, rubbing of the part and appropriate manipulation will often effect considerable stretching of the new tissue and diminish the deformity, but the tendency to contraction always remains. It has been thought that the scars of burns have a much greater and more confirmed tendency to contraction than those of other wounds. But it must be remembered that few other kinds of injury produce destruction over such a large and continuous surface, and probably the great degree of contraction is due rather to the large surface over which the scar extends than to any special contractile property.

The length of time which elapses before recovery from a burn of such a degree is naturally very variable. It is always much longer than that taken by slighter degrees, because here there are parts actually destroyed to a greater or less depth. Time is taken by the natural process of repair for the removal of these dead pieces of tissue, and then there is the still longer period required for the filling up of the breach. Moreover, in cases of burns the separation of dead pieces of tissue and the filling up of the gaps produced go on more slowly than in the case of injuries from other causes, which may involve equally extensive destruction. The actual time, of course, depends upon the depth of the destruction and the superficial extent, but the suffering and exhaustion caused by the tedious process are very great.

All these different degrees of burn, it will be observed, depend simply on the depth of tissue involved. In the first case only the immediate surface of the skin is affected, and that to a slight extent; in the second the action of the heat has penetrated partially through the epidermis or horny layer of the skin, in the third it has passed right through the skin and may have reached muscles, tendons, nerves, &c., below. The immediate result and the immediate danger of burns is the shock or state of depressed vital action (p. 990) which they produce. No other kind of injury produces so profound a lowering of the vital functions. This shock is often a very grave condition, threatening speedy death, and, even when it does not end fatally, is much prolonged. On whatever part of the body the burn is situated the shock is great, but it is most marked when it is the chest or abdomen that is affected; and it is more pronounced in women and children than in men. The seriousness of the shock is in proportion to the extent of *surface* involved, not in proportion to the *depth* of the injury. A merely superficial burn of the abdomen or chest of large surface will more readily prove fatal from the depression than a limited burn on an arm or leg, even though it extends almost down to the bone. If a burn involve more than half the surface of the body a fatal result is practically certain. The explanation of this is not clear. Commonly the death is due to the shock to the nervous system. But even when the shock is passed through, death occurs from other causes. In cases examined after death from shock, the internal organs have been found congested, and also the brain, and in cases in which the shock has passed off (in something like forty-eight hours) numerous symptoms point to these organs as being profoundly disturbed. For, following the shock, comes a period of reaction and inflammatory fever, in which, in addition to the bounding pulse and increased temperature, there are dryness and redness of tongue, thirst, loss of appetite, vomiting, and often diarrhœa. These symptoms indicate mischief in the digestive organs, and that inflammation of these organs occurs is shown by blood sometimes occurring in the motions, and by blood and albumin in the urine. Ulceration of the bowel may occur and inflammation of the lungs. The symptoms frequently resemble those of blood poisoning, which has led to one opinion that many of these complications are due to the functions of the skin being interfered with by the large extent of surface involved, and by the consequent retention in the blood of materials which the skin ought to have cast out of the body. Even when the symptoms of inflammatory fever have passed, which may not be for a couple of weeks, there is still grave cause for apprehension, specially in the case of women, children, old people and persons of indifferent bodily vigour, lest the drain upon the system involved in the prolonged suppuration and the exhaustion of continued suffering may completely undermine the strength and end in death by exhaustion.

The Treatment of Burns and Scalds.—The chief attention in the first place is to be paid to the condition of the patient, and until some steps have been taken in view of the shock which has been sustained the treatment of the injury may be postponed. This immediate treatment has been already sufficiently described under Shock (p. 991). The patient is to be laid flat in bed or on a couch with the head low, great care being exercised in the carriage and moving of him not to inflict further damage on the injured parts. Efforts are to be made to restore animation by the application of warmth to the surface of the body, and stimulants of hot tea or coffee, ammonia in water, whisky in water, or ether, if the shock be profound, are to be administered in one or other of the methods advised on p. 992. While this is being attended to by one person, others may be engaged doing what is needful for the injured parts. As already said, there is to be no hurry permitted in this. In the excitement of the moment persons are apt to proceed to tear off the clothes, thoughtless of the injury they may thereby inflict, and entirely unprepared, when the clothing is removed, with any suitable coverings for the burnt parts. Now two rules must be rigidly adhered to: (1) the clothes must not be *pulled off* the injured parts; they are to be carefully *cut off* by scissors or a sharp knife, and if any portion of clothing is adherent it is to be left rather than forcibly removed, the free parts being cut off; (2) the burnt surface must not be exposed before materials for quickly covering it are ready to hand. So completely ready must the dressings be that the exposure to the air of the burnt surface is of the smallest possible duration, otherwise the shock is likely to be aggravated. Some gauge of the superficial extent of the injury may be obtained from the appearances of the clothing, and suitable dressings may therefore be ready.

It is necessary, at the risk of repetition, to emphasize these points: *attend first to the effort to restore the patient from shock, then arrange suitable dressings, and do not remove the clothing till the dressings are ready for immediate application.*

Now the question arises, What are the suitable dressings? They are such as will protect the burnt parts from the action of the air, and will at the same time soothe them. Dredging the burn thickly with flour or whiting is sometimes resorted to in an emergency, but is not so suitable as the use of oil, because of the crusts it will form with the fluid from the burn, nor is it so likely to be at hand. It is better to cover the part with strips of lint soaked in oil, or sheets of cotton-wool well saturated with oil. In an emergency any oil will do, sweet-oil, almond or olive or salad or castor oil. But the oil most commonly employed is carron-oil, originally made of equal parts of linseed-oil and lime-water, but olive-oil is to be preferred for it. It is a most soothing application, and affords a most grateful relief to the patient. The smell of the preparation is, however, not pleasant, and it does not hinder the parts becoming foul-smelling. Some, therefore, prefer carbolic acid oil, 1 ounce of the carbolic acid to 40 ounces of olive-oil. If the pain be very intense the oil may be made of the strength of 1 of acid to 20 of oil; and this strength sometimes diminishes the sensitiveness of the surface in a very striking way. The carron-oil is, however, perfectly suitable to begin with, and antiseptic preparations may be used later if needful. Sheets of cotton-wool, of abundant size, soaked in this preparation, are then to be got ready and laid, on a plate or tray, by the side of the patient, before the clothing is removed. If blisters have already risen, great care is to be exerted not to tear them open in removing the clothing. If part of the clothing be adherent, cut round it, pour oil upon it, and then cover the whole surface, piece of clothing included, with the oily sheets of wool. If the burnt surface is very extensive, one part is not to remain exposed till other parts have been freed from clothing, but the dressings should be applied bit by bit, just as part after part is uncovered. It will greatly facilitate the process of healing if, in cases of blistering, the raised horny layer of the skin is allowed to remain as a protection to the parts below. All that is needful is to snip the blister at its lowest corner, and at any other part necessary to permit the complete escape of all the fluid, which is to be gently pressed out, and then the dressings applied. The oily covering having been adjusted, a large sheet of cotton-wool, the Gamgee tissue or carbolized gauze or any variety of antiseptic wool (now readily obtainable from druggists), should cover over all, and be fixed by means of a light bandage.

All this time someone must be paying attention to the patient, maintaining the warmth of other parts, administering stimulants, and so on. But the stimulants must be given with great discrimination in view of the subsequent inflammatory fever. The stage of shock will last from two or three hours up to twenty-four or forty-eight, according to the extent of the burn and the sensitiveness of the patient. The person must be guided by the pulse, the breathing, and the appearance of the skin, and on seeing indications of revival refrain from further use of stimulants, at the same time watching against a relapse.

The time of re-dressing must be determined not only by the state of the injury but also by the state of the patient. It is certain to be painful, perhaps exquisitely so, and to subject a patient to such pain who had hardly recovered from the shock of the injury would be very improper. It is indeed often deemed proper by surgeons to carry out the first one or two re-dressings with the patient under chloroform. The first dressing may quite safely be left for two or three days if the discharge from the burn is little or none, and there is no foul smell. But the appearance of any foul smell should suffice to determine its being immediately done. It must be carried out with equal care to the first. The new dressings are all to be ready before the first are removed; the first are never to be torn off. If adherent, they must be soaked by streams of water containing an antiseptic such as carbolic or boracic or salicylic acid, and the old dressing should be removed bit by bit, the new being applied in the same way. Any pieces of clothing left on the first dressing may now be easily removed by the stream of water. Where the destruction passes deeply into the tissues, so that sloughing is caused, frequent re-dressing and cleansing with antiseptic solutions becomes a necessity to prevent the putrefying appearance and odour of the separating pieces. Besides the carbolic lotion, Condy's fluid may be used for this purpose, or the perchloride of mercury lotion. Indeed, when the burn has reached the stage when the destroyed portions are separating, and still more when these dead pieces are separated and the wound is granulating, must the treatment adopted be similar to that already described for lacerated wounds, or a wound healing by granulation (refer to p. 968). When the scar tissue is forming and beginning to contract, great care and much patience and ingenuity require to be exercised to diminish deformity. In severe burns it is impossible to prevent all deformity, but it may be much lessened by the application of splints to hinder forced bending of joints, and by kneading, rubbing, and other manipulations when the wound has closed over.

In order to shorten the process of healing over of such extensive wounds, and to diminish deformity, the process of **skin grafting** has been introduced. This consists in snipping off from some healthy part of the body small pieces of skin, not throughout the whole depth but only from the surface layers of the skin. These fragments are planted on the surface of a healthily healing part of the surface of the wound, and hasten its covering in, lessening also the amount of shrinkage of the scar. A much more satisfactory method, however, consists in the transplanting of considerable pieces of skin. The size of the piece desired is marked out on a piece of paper, and this is laid on some part of the healthy body, arm or leg, and the extent of surface needed to be transferred thus accurately determined. This mapped-out piece of skin is now carefully dissected off with a clean sharp knife, the whole thickness of skin being removed. When the piece has been cut out, it is carefully trimmed, all fatty tissue from the under surface of the skin flap is carefully removed by scissors, and it is then placed in position on the desired portion of the wound, which has been cleaned and dried previously. The author has seen a piece of skin of the size of a half-crown piece thus removed from the arm and transplanted to the upper eyelid to fill up a gap, left after the cutting out of a piece of scar tissue by whose contraction the eyelid was being turned inside out, everted. The transplanted flap was retained in position simply by the pressure of clean lint and a lightly applied bandage. It took root, so to speak, became completely incorporated with the surrounding parts, and indeed almost indistinguishable from the surrounding skin, the form of the eyelid being very satisfactorily restored. When, first, flaps of skin were transplanted it was thought to be necessary to retain a connection by a sort of bridge of tissue with their old site, by which some blood supply was maintained till they had formed a connection with the new locality. This implied the removal of the transplanted flap from the immediate vicinity of the wound, or if the flap were removed from the arm to some part of the face it meant the binding up of the arm into close proximity to the face, and in a painfully constrained fashion, for many days. The newer method, which has shown that the skin may be completely separated from one place and yet retain vitality enough to become an integral part of another part, is due to Dr. Wolfe, of Glasgow, who has on several occasions employed it for the restoration of eyelids. It is especially serviceable in the case of scars of the face from burns or other injuries, which may seriously spoil the person's appearance, and in the case specially of a woman be a cause of much annoyance. In these instances the scar of the old injury is simply dissected out, a piece of skin the requisite size is removed from some part of the body, usually concealed by the clothing, and transplanted to the face. The new wound, thus produced, is allowed to heal up in the usual simple way. Professor Esmarch of Kiel has published (1889) the details of several operations he has performed by Wolfe's method on the face with great gain to the personal appearance of the persons.

Now we have described in detail the treatment of extensive and deep burns, which end in scarring. The treatment of burns, in which no great thickness of skin is affected, in which there may be blistering but no scar, is comparatively simple, except for the shock, which, as already said, may be even more grave than that attending deep burns of less area. The oily applications need less frequent renewal than in cases where there are sloughing and discharge, and from first to last nothing but oily applications may be necessary. The carron-oil may be used to the end without fœtor or discharge if the skin of the blisters have not been removed. To prevent smelling without giving up the use of the carron-oil some carbolic acid may be added to it (1 ounce of the acid to 40 of the carron-oil).

Many other applications are advised, specially at first when the pain is great. Among others, a saturated solution of common washing soda is advised as affording great relief, and a thin ointment of iodoform and vaseline. A mixture of chalk or whiting and vinegar is also praised for the speed with which it relieves pain.

For slight and merely surface burns immersion in cold water for a few seconds at a time will be found very soothing. Cold water applications laid on and left for any time are useless; they become so speedily warm. But if a stream of cold water be allowed to flow over the part for half to one minute at short intervals, or an iced cloth be applied, great relief follows for a little. When the stinging pain has thus been removed, enveloping the part in a thin layer of antiseptic wool or gauze is afterwards sufficient. Of course if the burn covered a large surface, however superficial it might be, one would be slow to use cold water in this way unless all fear of prostration had passed away.

These, then, are the means of treatment usually recommended to be employed. The author, however, has experience of another method, and though it is many years since it was applied on his own person he has still grateful recollections of its ease and its pain-relieving character. It consists in treating the burn by the application of carron-oil, but without any dressings whatever. The carron-oil is applied by means of a feather or brush on the burnt surface, into contact with which neither lint nor cotton nor any material whatever is allowed to come. It is only applicable to burns of the first and second degree, and not when there is separation of parts. The person lies in bed with the part quite uncovered and yet under the bed-clothes, this being accomplished by some contrivance which keeps the clothes off the skin. This is easily arranged. A wire guard can be procured to be placed over the burnt member, arm or leg, or to span the chest or abdomen or neck; and it bears the weight of the clothes. The person is kept perfectly warm, although the bed-clothes need not touch him at all except about the head. Such a guard can be easily improvised by using an ordinary wooden box or drawer. When the drawer is wanted to cover a leg or arm, one end is knocked out, and the box then placed over the limb. In the case of the leg it should be deep enough to permit the foot to rest on the heel. In the case of chest or abdomen, both ends are knocked out, and the box then placed over the body. With such an arrangement it is exceedingly easy to turn the bed-clothes partially down in order to reapply the carron-oil at frequent intervals. The surface is thus kept cool and comfortable and the pain and distress of each re-dressing completely avoided. Fig. 374 shows a common kitchen drawer prepared and in use for such a purpose.

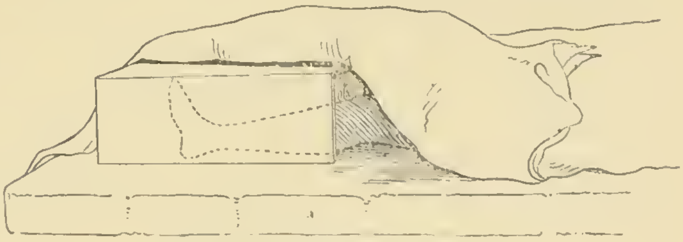


Fig. 374.—Protector for Burnt Leg.

Burns from Explosions of Gas, gunpowder, from contact with burning clothes, and so on, are to be treated on precisely the same lines. Every now and again one reads of severe injuries sustained by a person's clothing catching fire, and the person being extensively burned on face, hands, arms, neck, &c. Many of these accidents issue fatally, not from the actual injury, but from the combined shock of terror and the large extent of surface involved. Very many such accidents might be reduced to small proportions, if the person did not lose all presence of mind and go rushing about from place to place, and if spectators did not also lose presence of mind in witnessing it. A person whose clothing catches fire may quickly smother out the flames in many instances, at the risk of burning the hands, by firmly grasping the clothing and covering over the flaming parts with other portions unattacked. Or the person may throw herself or himself on the floor, and by rolling over on the part in flames extinguish it. Or the person may envelop herself in a plaid, overcoat, rug, shawl, &c., and then roll on the floor. Anyone near may help to extinguish the flame by throwing the person down and smothering out the flame with his hands or his own garments, or throwing a rug over the person, tightly enveloping him or her.

Scalds of the Mouth, Throat, and Gullet.—These accidents are more common in children than in adults, and are in children often due to the trick of drinking from a teapot or kettle spout. When the scald is limited to the fore part of the mouth the danger is not great, but great pain is caused, and the tongue may swell so much as to be forced out of the mouth. Cold water immediately used and freely and frequently repeated is advised, and, later, to the cold water a few drops of carbolic acid may be added, the mixture being well stirred before use. Sips of cold milk and iced milk are to be frequently given, and small pieces of ice to suck. When the throat and top of the gullet have been reached, the case is much more serious, for the top of the box of the windpipe is necessarily affected, and the swelling which very speedily arises may threaten to cause death by suffocation. A surgeon must be immediately sent for, since in the event of such a result being threatened, it may arise in a comparatively short time, and opening of the windpipe is the only sure means of permitting breathing to go on till the swelling subsides, though scarification may reduce the swelling sufficiently to prevent suffocation. In the meantime sips of iced water and iced milk are to be given, and small pieces of ice to suck. Of course shock will require to be treated as already described on p. 991. Even when the risk of suffocation has been averted, serious danger is not all past. If there has been any destruction of tissue in the gullet a scar results, and as healing goes on the resulting contraction may so diminish the diameter of the tube as to produce stricture, and render swallowing difficult if not ultimately impossible.

Burns from Chemicals, strong acids, such as vitriol, nitric acid or aqua fortis, spirit of salt, strong carbolic acid, quicklime, caustic soda or potash, are produced with great rapidity. The action of any of these substances penetrates deeply and quickly, producing destruction to a considerable depth, and always causing sloughing and scarring. So quickly are they produced that there is almost no time to obtain anything fully to antagonize their effects. Such acids will quickly burn through clothing. Cold water will probably be at hand in most instances, and is to be used freely. If the substance has passed over any extent of surface no mere washing will do. If abundance of water is at hand, the person should not hesitate to plunge into it and freely move about in it; or the limb affected should be thrust in and moved rapidly to and fro, or the head should be dipped in. No time is to be wasted removing clothing, the instant dilution of the substance with water is desired. In the case of acids any alkaline substance at hand, soda, lime, &c., should be added to the water to neutralize it; and in the case of lime, caustic potash or soda, acid—vinegar, for example—should be added. After this has been done, and as much of the corrosive substance removed as possible, the part may be treated as for an ordinary burn or wound.

Such corrosive substances are sometimes swallowed by mistake. Large draughts of water should be taken; in the case of acids, lime and water, soda and water; and in the case of solutions of caustic soda or lime or potash, vinegar and water. In the case of vitriol it must be remembered that the addition of water to it develops great heat, and great quantities of water would require to be taken rapidly. Lime could be torn from a wall and given with water. The immediate attendance of a medical man is necessary, for should the shock and other immediate effects be recovered from, prolonged and exhausting illness from ulceration and sloughing of parts is certain to follow, if any has reached the gullet and stomach. Indeed such cases are usually speedily fatal.

Burns of the Eyeball and Lids with dry heat, hot metal, &c., are to be treated with the atropinized castor-oil mentioned on p. 369. If lime has reached the eye a wash of vinegar and water, *never water alone*, is to be used, and if acid, a solution of soda or lime-water, or water alone, except in the case of oil of vitriol.

Sunstroke (*Heat-stroke, Heat-fever, Coup de Soleil, Insolatio*). Sunstroke appears really to include several diseases. There is first of all the form due to exposure to the direct rays of a hot sun, especially when they have been beating upon the head and neck. The liability to the attack is increased if the air is much heated, and if the person has been engaged in any laborious or exhausting occupation. Thus soldiers on the march, carrying heavy accoutrements and cumbered with clothing, are apt to be smitten in large numbers. This is common, wherever the direct heat of the sun is very great, and not only in India and tropical countries. It is also known in England. The symptoms very often arise suddenly, the person falling down insensible, and exhibiting all the symptoms of extreme nerve shock. The pulse is feeble and rapid, the breathing gasping, the skin is pale and cold, and death may occur quickly from failure of the heart and the breathing. These effects seem to be due to congestion of the brain and other nerve-centres; and if recovery occurs, while it may be complete, it is often imperfect, permanent changes in nervous structures leading to impaired intellect and generally enfeebled health.

Sometimes there are symptoms previous to the attack warning of its threatened onset. These are a feeling of great weariness and prostration, dizziness, sickness, restlessness and sleeplessness, dryness and heat of the skin, and incontinence of urine or a tendency to frequent passing of water.

But another form of the disease may occur, altogether without exposure to the direct rays of the sun. This may be produced by working in air heated by the sun's rays or by artificial means. Persons working in a confined space, with impure atmosphere, especially if depressed and exhausted by work, fatigue, or dissipation, or in a poor condition of general health, may be attacked. It is frequent in the case of soldiers in hot confined barracks, workmen, stokers or engineers on board ship, specially in hot climates. In summer such cases occur in many of the large swift steamers, where the men are kept working in the very hot and close atmosphere of the engine-room or stoke-room. This is specially apt to happen in certain conditions of the atmosphere, when the air is still and laden with moisture. In countries, such as Bengal, where the atmosphere is not only warm but damp, the liability to such an attack is greater. For a hot atmosphere which is also dry is tolerated far more readily than one which is moist. In the dry hot atmosphere, evaporation from the skin is encouraged, and the temperature of the body kept down, but this is prevented in the case of air already laden with moisture. This variety is called **heat-fever, or ardent fever**, and is common in India, attacking not only foreigners but natives also, though the latter can tolerate a much higher degree of heat than the former. To this variety also persons with enfeebled general health more readily succumb than those of sound and vigorous constitution, who live healthy temperate lives free from any vitiating influences. The attack may occur in the shade, at night, just as much as in the daytime or in the sunlight, provided the person is under the depressing influence of a close confined atmosphere, vitiated by overcrowding.

In cases of this variety the fever induced by the heat is very high. There is great weakening of the heart, the breathing is quick and gasping, the skin burning, thirst is great, and there is marked restlessness, and frequent calls to pass water. The skin of the face, head, and neck is congested with blood and livid; and the pupils dilate widely before death. If death is about to occur, its approach is heralded by delirium and convulsions, stupor, involuntary evacuation of the bowels, and suppression of urine. Recovery may occur, but not complete, impairment of intellect and feeble health being the consequences of inflammatory changes in the brain and injury to other organs. Recovery may seem to set in to be followed by relapse. When death occurs it is usually within twenty-four or forty-eight hours.

Symptoms may occur for some hours or even days before the illness develops, significant of what is about to follow. A general feeling of ill-health, restlessness, and sleeplessness, disturbances of bowels and bladder, sometimes thirst, loss of appetite, a feeling of sickness, giddiness, headache, a feeling of anxiety, and a sense of impending evil, and quick short breathing are among these premonitory symptoms.

A milder form of illness due to exposure to a hot atmosphere in the circumstances already mentioned is called **heat exhaustion**. Its symptoms are those of nervous collapse, the skin is cold, pale, and clammy, pulse quick and weak, there is complete prostration of muscular strength, and while complete recovery may be effected by appropriate treatment, death may take place suddenly from failure of the heart.

Treatment of Sunstroke and Heat-fever. In the last condition mentioned, that of heat exhaustion, the patient should be removed to a cool room or place where the atmosphere is fresh. All heavy and tight clothing should be removed or loosened, cold should be applied to the head and back of the neck either in the form of an ice cap or in the form of a cold douche. The application of cold, however, must not be pushed too far, lest it lead to further depression of vital powers. For the rest, stimulating treatment may be needful; smelling salts, not too strong, should be held to the nostrils for an instant or two at intervals; weak liquor ammonia, 15 drops at a time, well diluted with water, may be given by the mouth, or weak spirit and water, and nourishing food must also at frequent intervals be administered if possible. At the same time stimulants must be administered with great caution, and discontinued as soon as signs of returning animation appear. If rashly and inconsiderately used they are certain to aggravate the condition of reaction which follows the collapse. It may be necessary to maintain the breathing by artificial respiration.

In the case of heat-fever, cold is also to be applied to the head and spine, as an ice bag or cold douche. Here again care must be taken not to produce depression. But the ice application may be continued at frequent intervals until the heat of skin abates and the fever is reduced. This should be ascertained, if possible, by a thermometer whose bulb is passed up into the bowel (see p. 10). If consciousness does not return, blisters may be applied to the nape of the neck, and, after shaving, to the back of the head. The bowels should be freely relieved, though not powerfully purged. The use of food and stimulants may be adopted on the lines already indicated. At one time bleeding was advocated to relieve the turgid and livid appearance of the head and face and the laboured breathing, but is not now advocated, it being recognized that any measures which further reduce the patient's strength are only likely to make a fatal termination certain.

When a person drops suddenly to the ground with sunstroke, he is to be immediately removed to the shade and a stream of cold water is to be poured from a height upon his head, neck, and body, as he lies stretched out on the ground. All tight and heavy clothing should be removed; and if the cold water be immediately and freely applied a return to consciousness will very often be brought about. Injections to relieve the bowels, and mustard applications over nape of neck and heart, may be required.

Any person who has suffered from any form of sunstroke should be exceedingly careful to avoid any subsequent exposure. Those who have recovered either wholly or partially from the severer forms should seek immediate removal to a cooler climate. Even in a temperate climate much exposure to a warm sun should be avoided; regularity in habits of body should be rigidly practised; and the person should abstain completely from all forms of alcoholic stimulants.

The mortality from sunstroke is estimated at between 40 and 50 per cent, and of those who do recover, many retain some permanent indication of the attack in some form of nervous weakness or disturbance of greater or less severity.

Lightning Stroke.—Death may be caused instantaneously by lightning and no trace of its action be visible, the sudden shock to the nervous system having immediately arrested the vital functions. In other cases evidence of the stroke is found in greater or less amount. Wounds may be produced of a character to mark off one in the position where the current entered and another as its point of exit. The clothing may be rent and torn from the body with great violence; boots may be riven in pieces, metallic bodies in the pockets, a knife, keys, a watch or chain, may have attracted the current and be fused, broken to pieces, or magnetized. The body itself may suffer in a great variety of ways, internal organs may be disorganized, and the skin may be scorched. Scorchings of the skin very often assume a curious branching tree-like arrangement according to the way in which the electric fluid has swept over it. It was at one time a popular belief that such markings were photographs of some tree in the neighbourhood of the place where the person was struck. A person may be so struck that a limb is separated from the body, though this is not common. A person who is not directly struck, but is in the immediate neighbourhood of the place struck, may yet be seriously injured. The effects resemble those of concussion of the brain (see p. 104), weak pulse, slow feeble breathing, dilated pupils; and the person may remain unconscious for a considerable time, from a few minutes to hours or even days. The effects produced may be but slight, sudden giddiness, confusion, faintness, recovered from in a few minutes. The more serious cases may be attended by paralysis of the limbs or affection of the senses, blindness, wholly or partially, loss or perversion of smell, deafness or noises in the ears, &c., loss of memory and some affection of brain may remain. Paralysis arising from lightning stroke may be removed sooner or later. Trees are very often struck by lightning, and it is regarded as unwise to take shelter under them during a storm, but the beech-tree is said never to be assailed, and it is in many places believed that it is impossible for one sheltered under it to be struck.

The treatment of lightning stroke consists at first in the treatment appropriate to concussion of the brain or nervous shock from other causes. Efforts are to be made to restore animation by friction of the limbs, the application of warmth to the body, and, if it appear needful, the judicious use of stimulants. The cold douche suddenly applied and quickly suspended is said to be of great value for rousing the circulation and breathing. Breathing may require to be maintained artificially

Electric Shock differs in no essential particulars from lightning stroke, when it is received in sufficiently intense currents to be injurious. Any differences that occur are only differences in degree. Death by electricity is unhappily becoming now a common accident, in many cases being attended by features of special horror. Reports of electric lighting employees being killed by electric shock from overhead wires while working on house roofs, and of the body, entangled by the wires, being slowly scorched, are becoming painfully numerous. Persons cannot be sufficiently on their guard against touching in any way any electric conductors, and specially against touching or stepping on any overhead wire that may have fallen and be lying on the footway. Though it might be only a telegraph or telephone wire it is wisest to err on the safe side.

THE EFFECTS OF COLD.

Long-continued cold acting upon the whole body produces general depression, which is manifested by a feeling of coldness and chilliness, followed by uneasy tingling of the body. The skin is pale and corrugated. The body gradually feels benumbed, and with the languid circulation a sense of languor and drowsiness creeps on, to which the person is almost irresistibly inclined to yield himself. His muscular power becomes very feeble; he is oppressed with a feeling of weight and an intense desire to sleep; his ideas are confused and his mental faculties blunted, and if not almost forcibly prevented he yields to the languor that overpowers him and lies down. The cold continuing to act upon him, the heart's action becomes feeble, quick, and irregular; breathing is laboured and slow; the pupils of the eye dilate; a heavy stupor overtakes him, ending in death. In other and less extreme cases the effects upon the nervous system are manifested, not in stupor, but in delirium, wandering or raving in character, and sleeplessness.

The **treatment** of a person thus overpowered must be carried out with great care. It is universally admitted that any sudden change from the state of cold to one of heat is to be entirely avoided as likely to prove fatal. The restoration of warmth must be very gradual. The person should be divested of his clothing and laid, rolled in cold blankets, in a *quite cold room.* Rubbing the body with ice or snow is commonly recommended, and this may be alternated with light friction with cold flannel or fur This must be persevered in for hours if necessary. When the patient shows signs of returning animation the room may be very slightly warmed. With the return of consciousness pains may be complained of in the limbs, especially if they have been warmed too rapidly, and it is deemed advisable to envelop the limb in cloths soaked with cold water. As gradual relaxation of the stiffened parts occurs, some slightly stimulating liniment may be employed with which to continue the rubbing—soap-liniment, tincture of arnica, or camphorated spirit. Mildly stimulating drinks are then given, warm tea, coffee, beef-tea, or soup, but no alcoholic stimulants till later. In fact the restoration of the bodily heat must be brought about very gradually throughout, and the frictions of the whole body must be steadily maintained but never in too vigorous a fashion. *The efforts at restoration must be persisted in for many hours.* The following case, occurring in America, may be given in illustration: "An Esquimau had his leg frozen above the knee-joint, stiff, colourless, and to all appearances lifeless. He was placed in a snow-house, at a temperature of 20° *below* zero (Fahrenheit). The parts were bathed in ice-cold water for about two hours, and then enveloped in furs for three or four hours. Then frictions were used, first with the feathery side of a bird-skin, then with snow, alternately wrapping the limb in furs and rubbing it for nearly twenty-four hours. It was next carefully wrapped up, and the temperature of the snow-house raised by lamps above zero. On the third day the patient was taken to his house (in the Esquimaux houses there is often a temperature of 70° or 80° Fahrenheit), and in seventy hours was walking about, with only a slight frost-bite on one of his toes." "This case," adds the narrator, Dr. Hayes, "shows how much may be accomplished with care and perseverance, even under the most adverse circumstances."

Some interesting experiments made by Pflueger, a German physiologist, throw some light on the cause of the difference between slow and rapid warming after an intense degree of cold. He experimented with frogs, and after freezing a frog till it was as hard and stiff as a board, he thawed it out very slowly, with the result of restoration of animation, the frog being able to jump about though in a languid way. The author has himself seen a frog hopping about, which, hours before, had been frozen hard in a Bell-Coleman freezing-machine. The idea of Pflueger's explanation is, that if rapid thawing occurs the waters of the tissues separate out, and the tissues are left in a moist dead state, while if the thawing be accomplished slowly enough the water is taken up and organically incorporated with the reviving tissues.

A person who is subject to intense and long-continued cold must be encouraged to move actively about. The desire to sit down and yield to the languor must be combated in a most determined manner. Stimulants, at least alcoholic stimulants, are not to be administered. They are harmful rather than useful, because, as explained on p. 673, they rather accelerate the loss of heat from the body by dilating the blood-vessels of the skin. A sharp, clear, dry cold is much less hurtful than a damp cold, for the moisture of the latter soaks the clothing and causes them to become better conductors of heat, so that heat is lost from the body with much greater rapidity. Naturally, persons who have been subject to prolonged fatigue and insufficient nourishment will yield to the influences of cold much more rapidly than those who are fresh and well nourished. While alcoholic stimulants are objected to, warm stimulating articles of food, that is to say substances which nourish as well as stimulate, warm soup, beef-tea, milk, &c., may be freely taken by those exposed to cold.

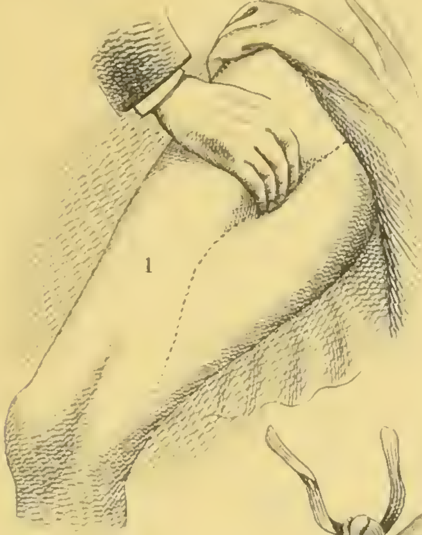
As a protection against external cold nothing is equal to a fair quantity of fat in and underneath the skin. The thin man will, other things being equal, succumb long before the fat man. Then in cold weather and cold climates the heat-producing articles of food, specially fat, should be freely consumed (see p. 619), and non-conductors of heat used for clothing (see p. 723).

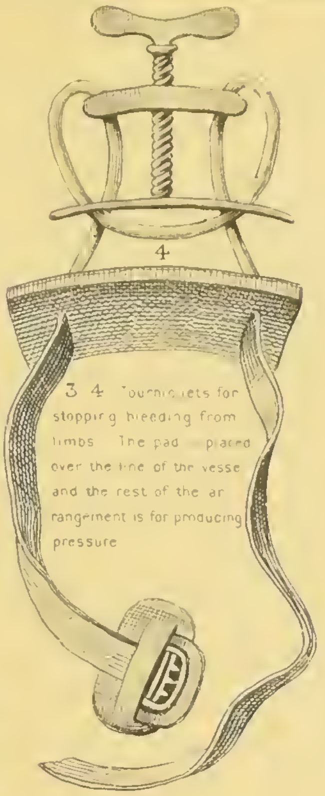
Frost-bite is the condition of coldness, numbness, and loss of power attacking a part of the body, exactly the condition already described as affecting the whole body, but limited to a part of it. The parts usually affected are the extremities, the toes and fingers, feet and hands, nose and ears, because these are the parts at greatest distance from the centre of circulation. There are various degrees of frost-bite, as there are various degrees of burn. The frost-bite may only be sufficient to produce coldness and numbness of the affected parts, the skin of which becomes white and wrinkled; and, when heat is restored, marked reaction occurs with redness, heat, tingling, itching, and swelling of the parts. The more rapidly the change from cold to heat occurs, the more marked and violent is this inflammatory reaction, but it soon subsides, and restoration to the normal state occurs. If the cold be more intense and longer applied a second degree of frost-bite occurs. Complete loss of sensation takes place; the parts become discoloured, blisters form filled with fluid, which may be clear but is often bloody. If the cold have been so intense as to freeze the part through and through, it will be hard, stiff, and brittle, and in this state the part might actually be separated from the body by breaking. Usually, however, the parts are purple, have lost feeling, and, if pricked, only a drop of dark blood escapes. One must not conclude that restoration of such parts is hopeless; for by appropriate and careful treatment recovery from even this degree of frost-bite is possible. In a greater degree of frost-bite the death of the part is complete, it passes into a contracted shrivelled condition, and drops off from the body, a red line of demarcation marking the separation between the dead and the living. That is to say, the part separates by gangrene.

The **treatment of frost-bite** is identical for that already described for the whole body benumbed by cold. Under no circumstances must a sudden change from the intense cold to heat be indulged in. A person who, after long exposure to cold, at last reaches shelter with a hand or a foot or fingers or toes in this benumbed condition, is apt to seek the immediate aid of external heat, of a warm fire, of hot water, and so on. This is attended by grave danger not only to the benumbed parts but also to the whole body. Numerous illustrations of the danger of such procedure are derived from the

METHODS OF ARRESTING BLEEDING.

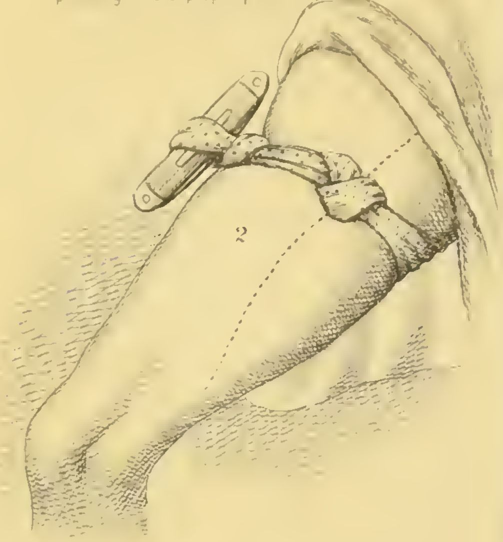
1 Line of artery of thigh and position in which to exert pressure to stop bleeding

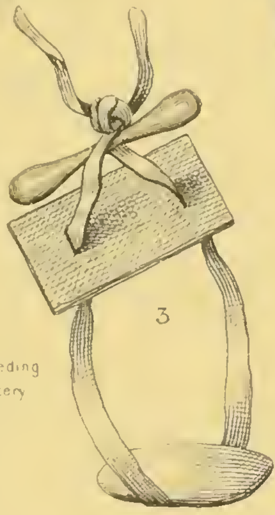




3 4 Tourniquets for stopping bleeding from limbs The pad is placed over the line of the vessel and the rest of the arrangement is for producing pressure

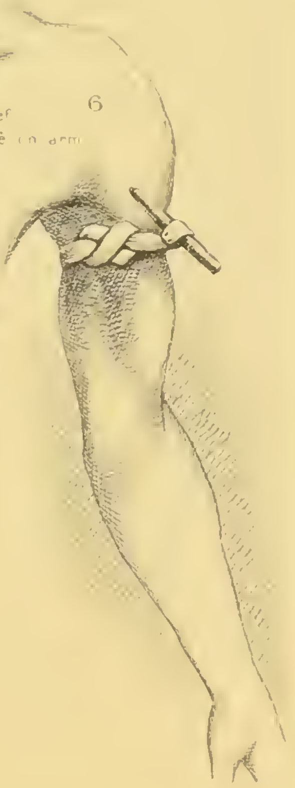
2 Arrest of bleeding from foot or leg by knotted handkerchief twisted by means of a pocket knife the knot pressing on the proper place

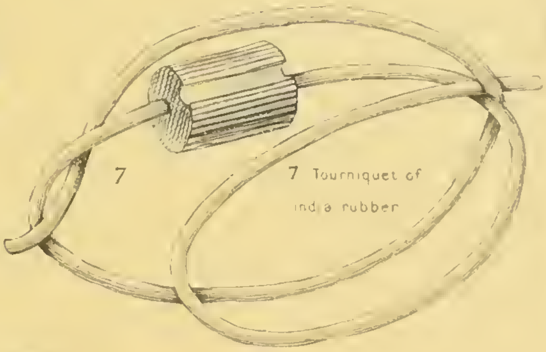




5 Forceps for picking up bleeding end of cut artery in a wound

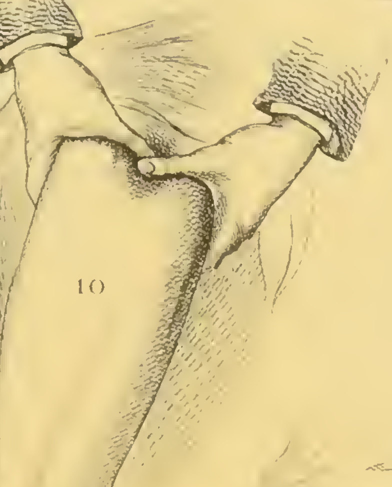
6 Knotted handkerchief applied to proper place in arm



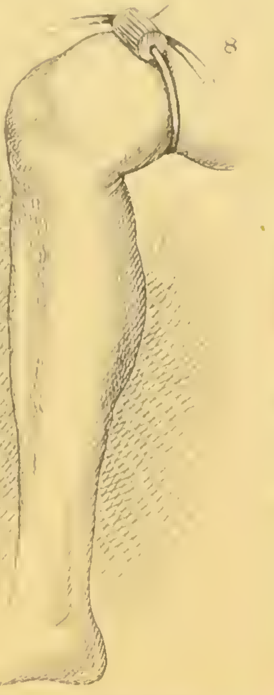


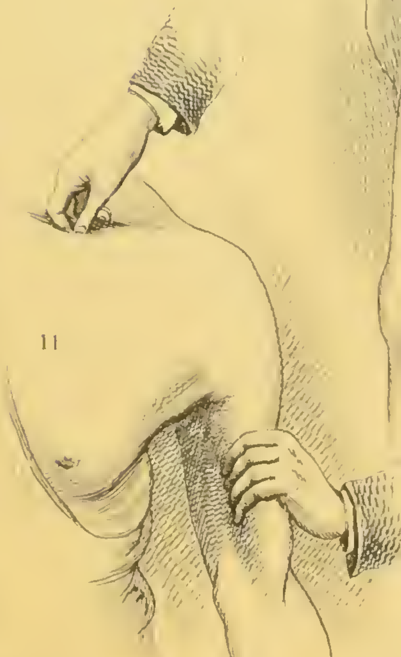
7 Tourniquet of india rubber

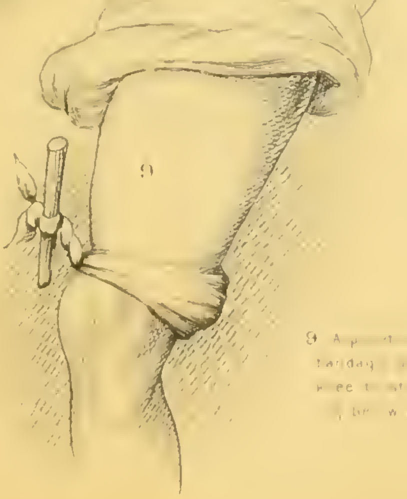
10 Stopping bleeding in the leg by pressure of the thumbs over the main vessel of the thigh



8 Tourniquet of india rubber applied to the leg







9 A position of bandaging [illegible] knee to stop bleeding [illegible]

11 Two places in which pressure might be exerted to stop bleeding from the arm

experience of armies in the field. Soldiers, exposed for long periods to the cold, at last seek the warmth of the camp fire and stretch out their benumbed hands and feet to the blaze, only to determine gangrene of the extremities by the sudden transition. It has even been noticed that such results followed, in the case of troops exposed to a cold night-watch, if a sudden thaw set in, the mere natural transition from a low to a much higher temperature being badly borne by the frost-bitten parts.

The treatment, then, that is invariably advised is gentle friction, at first with snow or ice-cold water in a cold room, and a very gradual elevation of temperature as a gradual return of animation becomes evident. As the limb begins to approach the normal degree of heat, it may be wrapped in flannels or furs or cotton-wool. If the part does not recover, the separation about to be effected by gangrene is revealed by the appearance of a red zone between the living and the dead parts. In the case of fingers and toes, warm linseed-meal poultices are commonly employed to aid the separation of the slough. To keep down smell antiseptic dressings are employed as in the case of wounds, and when the dead part has been removed the stump is to be treated in the ordinary way as a granulating wound (p. 972). During this period the strength of the patient requires maintenance by nourishing food, perhaps also by stimulants and tonics. In the case of a foot or hand or a large portion of a limb, as soon as gangrene became evident, a surgeon would perform an amputation to save the patient the prolonged suffering and exhaustion of the natural method of separation, and to get rid of the risks of blood poisoning which might otherwise arise.

Parts which have once been frost-bitten and have recovered are liable, on a repetition of the exposure, to a repetition of the attack. Care should therefore be taken, by the use of extra protection by woollen material or fur, to guard against such a return.

The milder degrees of frost-bite require caution in the application of heat, but are usually rapidly recovered from. Rubbing with snow, and subsequent wrapping of the parts in flannel or fur with gradual elevation of temperature, will commonly suffice; and, when the parts are restored to a normal degree of heat, light friction with some of the stimulating liniments or ointments recommended for chilblains will be useful.

Chilblains are degrees of the effects of cold milder than frost-bite. A part of the skin is in a state of inflammation due to cold. There is some amount of swelling, redness, heat and tingling, and the itching pain is increased by heat. The patch of skin, in cases of greater severity, may be purple or livid, and blebs or blisters may form upon it. The blisters may break and leave a suppurating or ulcerating surface.

The treatment of chilblains is conducted on similar lines to that of frost-bite. Warmth is not to be restored, after the exposure, by hot water or by holding the part before the fire. Rubbing with snow or iced water is again recommended, or simple gentle friction with the hands. Later a liniment of opium or soap and opium, and subsequently a more stimulating liniment, such as camphor liniment or turpentine liniment or tincture of iodine, are recommended. If the skin is not broken ointment of iodine is said to be one of the very best of applications. After this the part should be enveloped in flannel or carded cotton.

While the fingers and toes are usually attacked, the nose and ears frequently suffer; and if in one winter season the ears of a person have become affected, the probability of a recurrence the following season should be remembered and precautions taken.

Young persons are specially prone to be attacked by chilblains, and specially such as are not of vigorous constitution.

The prevention of chilblains is better than their cure; and if it is remembered that it is not the mere exposure to cold that determines their occurrence, but the sudden change from severe cold to heat, one of the chief means of prevention is indicated. Persons with chilled fingers or toes *must keep from the fire* till the heat of the parts has returned naturally. Then, of course, efficient protection should be provided for hands, feet, ears, &c., by the use of suitable clothing, woollen stockings, snow-shoes, woollen gloves, &c. Active exercise during exposure to the cold, and rubbing, should be engaged in to prevent the numbing of parts.

SECTION V.—SUFFOCATION OR ASPHYXIA. RESTORATION FROM THREATENED DROWNING, CHOKING, HANGING, STRANGULATION.

Suffocation or Asphyxia:
  Its Causes, Stages, and Treatment;
  Suffocation from Foul Gases and its Treatment.
Drowning:
  Methods of Artificial Respiration—Sylvester's, Howard's, Marshall Hall's.
Choking.
Hanging and Strangulation.

SUFFOCATION.

Suffocation is the condition which arises when an animal is deprived, by any means, of a due supply of air fitted for maintaining the proper condition of the blood. In Part I., Section IX., p. 249, the purpose of breathing has been described at length. Its purpose is two-fold. The gas called oxygen is needed in the body to effect the chemical changes by which the nourishment taken is converted into power of doing work or energy, and into heat, and by which the integrity of the body is maintained. By the work of the body a gas, called carbonic acid gas, is produced, which if allowed to remain in the body becomes speedily injurious, acting as a poison. The fuller explanation of these facts will be obtained in the section already named, and in the early paragraphs on food, p. 531. Now the lungs are the organs by which at once new supplies of oxygen are introduced to the blood and carbonic acid gas removed from it. We do not breathe pure oxygen, but the ordinary atmospheric air we breathe contains oxygen, diluted with a neutral gas, nitrogen. Now any circumstance which will prevent the blood obtaining its proper supplies of oxygen will produce symptoms, more or less marked according to the degree to which the oxygen is wanting. These are symptoms of suffocation, using the word in its scientific sense, or, to use the scientific term, **asphyxia** (Greek *a*, not, and *sphuxis*, the pulse). The literal meaning of this word is, therefore, pulselessness, though it is used to mean the condition described. The early symptoms, and the symptoms which arise when the deficiency of oxygen is not great, would not be popularly recognized as symptoms of suffocation, but simply as symptoms of difficult and laboured breathing (p. 284), or **dyspnœa** (Greek *dus*, with difficulty, and *pneo*, I breathe), for in the popular mind the term suffocation is used to imply the condition in which the person is, from want of breath, in immediate danger of death. Nevertheless, these symptoms are merely the early symptoms of a slight degree of that condition in which oxygen is not gaining entrance to the blood, which, if it becomes aggravated, is readily recognized as a state of suffocation.

It is quite clear, then, that suffocation or asphyxia may arise from a great many causes, and not merely from the commonly recognized cause of blocking the windpipe by pressure from without or by something falling into it from the mouth. Suppose a person's lungs are in thoroughly good order, but he is placed in a small confined space into which no fresh air can enter. By and by he will so have exhausted the supply of oxygen in the air of that apartment that he can get no fresh supplies into his blood. He will die from want of fresh air, from want of oxygen, from suffocation, just as much as if he had been seized by the throat and strangled. Of course there will be an additional element present, namely, that he has not only removed from the air all the oxygen he can, but he has polluted it with carbonic acid gas and other exhalations from his lungs, so that it will not be a pure case of suffocation, though it is that chiefly. Again, let us suppose that there is abundance of fresh air about a person, but that both lungs are blocked up with products of inflammation, as in inflammation of the lung, and that the air cannot penetrate to the recesses of the lung to reach the blood. Again he will die of suffocation, not from want of air or of oxygen in it, but because he cannot make use of it, the inflammation being the cause of his inability. Or let us suppose he has pleurisy of both sides, and that large quantities of fluid have been poured out round the lungs, causing them to be squeezed up into a corner of the chest, emptied of air, and prevented expanding, asphyxia again arises. Still again let us suppose that the atmosphere about him is pure enough, and that his lungs are in a healthy state, but that there is a growth in his windpipe which gradually encroaches on its fairway till the passage for air is seriously blocked, clearly suffocation will arise. Take the case of membranous croup, diphtheria of the larynx or box of the windpipe in a child. The membrane which grows in the larynx rapidly narrows the passage for the air, and the child gasps and fights for the air that is around it in abundance, but which cannot pass the narrowed part of the tube sufficiently quickly for its purpose, and finally, if the membrane continues, the child dies of suffocation, worn out too by its struggles for breath. Once more, suppose a mass of food has "slipped down the wrong way" and gained entrance to the windpipe, which it blocks, suffocation again immediately arises, the person is deprived, at a stroke, of oxygen by the block in the pipe. Lastly, suppose the mouth and nostrils are stopped, or the windpipe closed by the hand of a garroter, or by the person's head being buried in sand or earth, or immersed in water, as in drowning, or the windpipe compressed, as in hanging or strangling by a rope, clearly the result in all cases is the same, no new supplies of oxygen gain entrance to the blood, and in all the death is by suffocation or asphyxia. If a person or animal were to be lowered into a pit or jar containing nitrogen gas only, the same condition would arise, death from want of oxygen, death from suffocation.

It is quite true that in most of these cases not only is there want of sufficient oxygen, but there is also hindrance to the output of the impure carbonic acid gas, and the retention of this gas in the body is undoubtedly a contributing cause to the death. But this added element of poisoning by accumulation of carbonic acid gas does not produce the characteristic symptoms of suffocation or asphyxia, the laboured breathing, the fight for breath. It has been proved that an atmosphere containing abundant supplies of oxygen, but also a poisonous amount of carbonic acid gas, will still produce death, but no longer attended by the symptoms of suffocation, but with the symptoms of narcotic poisoning. Headache, languor, stupor, unconscious and quiet death are now the result, not the struggle and convulsions of suffocation. To repeat, the symptoms to be described as those of suffocation are due to want of oxygen, from whatever cause that want may arise.

Symptoms.—The symptoms are best seen in all their intensity when the want of oxygen is sudden and extreme, as in drowning, choking, strangulation, and they occur in three stages. There is first the stage of dyspnœa or laboured breathing. It is a state of agitation and struggle. The movements of breathing are rapid, deep, and powerful. The ordinary muscles which produce the movements of the chest and abdomen are not only thrown into a state of intense activity, but the muscles of extraordinary respiration (p. 254) as well. The muscles between the head and chest and between the arms and chest, &c., are active, raising and pulling down the chest in the effort to get more air into the lungs. The movements of breathing are deep, prolonged, and hurried, passing into convulsive gasps for breath. This stage lasts for a minute or a minute and a half, and latterly spasmodic movements of the limbs occur. Meantime the veins of the face and surface of the body become swollen with dark-coloured blood, and the countenance is livid. In the second stage, the muscles which expel air from the lungs contract spasmodically, and this passes into a state in which nearly every muscle of the body acts convulsively, the bowels and bladder being emptied involuntarily, and general convulsions setting in. It lasts about a minute and passes into a state of exhaustion, in which the person lies still, the pupils being widely dilated; there is complete insensibility; the muscles are completely relaxed. Every now and then, however, there are a few convulsive gasps, which become weaker and feebler. Finally, a general convulsion occurs, in which the body is fully stretched out, the mouth is widely opened, and the nostrils dilated, the head is thrown back and the back straightened, and in one final effort to draw in breath the effort is over. The heart continues to beat for a few seconds longer, and at length stops in complete relaxation, when death has occurred. The whole period that elapses between the moment of complete deprivation of oxygen and death is 3 to 5 minutes. It varies in different animals; and young animals seem to be able to hold out longer than full-grown animals. At any moment in the period named, until the instant before the heart has ceased to beat, when the person is perfectly still and death seems already to have occurred, restoration is possible, if only oxygen can be introduced into the blood. The heart may still be feebly beating, even when no pulse can be felt.

The appearance of the body fully indicates the cause of death. The veins of the skin and of head and neck are gorged with dark blood;

and the face and head are swollen and turgid, and darkly purple or almost black.

All the movements that have been described are directly due to impulses to muscles from the nerve-centres, which are violently stimulated by the non-oxygenated state of the blood. They are completely beyond the control of the person, are not voluntarily made, and can occur from first to last even in a state of profound unconsciousness. The struggles thus made by a person are not, therefore, necessarily attended by pain, however painful and distressing they are to witness.

Treatment.—The perfectly clear indication for treatment is to render the admission of air to the lungs easy, if that be possible. In a case of inflammation of the lungs or of pleurisy, such as has been described, that could only be done by clearing the lungs or removing the pleuritic fluid. If the want of air be caused by blocking of the windpipe by something that has dropped from the mouth, it may be possible to remove it in the manner to be described under the head of choking. If the obstacle cannot so be removed, and if it be lodged high up, the admission of air may be rendered easy by making an opening into the windpipe from the neck, by the operation known as tracheotomy. If the person has succumbed from being in an atmosphere wanting in oxygen, removal to the outside air is the immediate step to be taken, and the loosening of the clothing about the neck and waist. If the person has been removed into pure air before the heart has ceased to beat, but when already the last stage of suffocation has been reached, and he lies quiet, making no effort to breathe, the movements of breathing may be stimulated by sudden dashing of cold water on the chest, or by flicking the chest with a wet towel. That failing, immediate effort must be made to produce artificial breathing by Sylvester's or Howard's method, described under Drowning, the preliminary step of removing water from the chest being, of course, unnecessary. In the case of children, especially, mouth-to-mouth insufflation may be practised, though Howard's method is best.

In the case of persons overcome by foul air in wells, pits, or in the recesses of quarries after blasting by gunpowder, they are to be quickly removed into fresh air, the clothing about the neck is to be rapidly unloosed, and artificial respiration practised.

Drowning means death by the air being prevented entering the lungs owing to the mouth and nostrils being immersed in a liquid, the liquid being commonly water. Death may, therefore, occur by drowning in a small quantity of water. Thus a child may fall head downwards into a tub and be drowned, though the tub is not half full of water, sufficient to cover the mouth and nostrils being all that is necessary, and a man overcome by a fit or by drunkenness may fall on a road with his head in a ditch or pool of water, and thus meet death. Death is thus due to suffocation, to the stoppage of breathing, and to the entrance of water into the lungs. When death has been caused by drowning, the skin presents the appearance called goose-skin (*cutis anserīna*), the face and surface of the body generally are usually pale, a frothy liquid is found in the lungs and air-passages, and about the lips and nostrils; water may be found in the stomach; and clenched fingers, holding substances grasped at, may serve to show that a struggle has taken place in the water, and that the body was alive at the time of immersion. Complete insensibility arises, it is probable, in from one to two minutes after submersion, recovery, however, being still possible, and death occurs in from two to five minutes. So long as the heart continues to beat, recovery is possible; after it has ceased it is impossible. Newly-born children and young puppies stand submersion longer than the more fully grown.

For the restoration of the apparently drowned several methods are suggested. Those of Dr. Sylvester, recommended by the English Humane Society, and Dr. Benjamin Howard, of New York, are the simplest, but that of Dr. Marshall Hall will also be described.

Whichever method is adopted, the following steps must first and immediately be taken: Pull the body up on to dry ground. Send immediately for medical assistance, warm blankets, dry clothing, brandy and hot water, if anyone is at hand to send. No delay must be permitted, however, in treating the person, so that if only one person is on the spot he must begin to treat the person *instantly*, without seeking assistance. Remove all clothing from the neck and chest. Fold the articles of dress removed so as to make a firm pillow, which is to be placed under the shoulders, so that the upper part of the body is slightly raised and the head slightly thrown back. Cleanse the mouth and nostrils, open the mouth and pull forward the tongue. If natural efforts to breathe are made, try to stimulate them by brisk rubbing of the sides of the chest and of the face. If no effort to breathe is made, proceed to produce the entrance and outflow of air from the lungs by Sylvester's or Howard's method.

Sylvester's Method (Plate XVII.).—Stand or kneel behind the person's head, grasp each arm at the elbow, draw both arms simultaneously upwards till they are extended in line with the body, as a man places them when he stretches himself. Let this movement occupy about 2 seconds. This enlarges the chest and causes the entrance of air to the lungs. Without a pause carry the arms down to the sides, making them overlap the chest a little, and firmly press them on the chest. This movement should occupy other 2 seconds. It expels air from the lungs. Repeat the movements, and maintain them steadily and patiently at the rate of 15 times a minute, until breathing has been fully restored, or until medical aid arrives, or until death is certain. An hour is not too long a time to persist, and so long as there seems the least effort to breathe the efforts must be persevered in.

Howard's Method (Plate XVIII.).—Place the body on its face, with the roll of clothing under the stomach, the head being supported on the hand as shown in figure 1. Pull the body over the roll of clothing to expel water from the chest. Then turn the body on the back, the shoulders being supported as shown in fig. 2. Kneel over the body. Place both hands on the lower part of the chest, so that the thumbs hook in under the lowest ribs and the fingers are spread out on the chest. Steadily press forwards, raising the ribs, your own body being thus thrown leaning forward. This enlarges the cavity of the chest and causes air to enter. When the ribs have been raised to the utmost extent, with a slight effort push yourself back to the more erect position, allowing the ribs to recoil to their former position. This expels the air. Repeat the process 15 times a minute. One person will find it more easy to maintain this method for a prolonged period than Sylvester's, especially if the patient be big and heavy.

Meanwhile, if other persons are present they should be occupied rubbing the body and limbs (*always upwards*) with hands or warm flannel, applying hot flannels, bottles, &c., to the limbs, feet, arm-pits, &c. As soon as the person is sufficiently restored to be able to swallow, give small quantities of hot brandy and water, hot wine and water, hot coffee, &c., and use every effort to restore and maintain warmth.

Marshall Hall's Method.—After clearing the mouth and throat let the operator kneel on one side of the patient, who is placed on his back with the arm opposite the operator close down against the side, a folded coat or other article of dress being under the back. From this position let the operator turn the body up, away from him, on to the side and slightly farther so that the chest looks to the ground, and in this position let the operator press firmly on the side and back. This compresses the chest on the under arm, and expels the air. Let the pressure be removed and roll the patient slowly on to his back again. The chest expands slightly and the air enters. These movements are to be repeated steadily and regularly, about fifteen times a minute, once every four seconds. If another person be present let him attend to the movements of the head to keep it in line with the body as it is turned. The movements of the chest are not nearly so pronounced by this method as in Sylvester's or Howard's, but one man can perform them for a long time. This advantage is also possessed by Howard's method, which in addition causes much greater movement, and is, therefore, to be preferred.

Choking is caused by something slipping down from the mouth and blocking, more or less completely, the upper part of the air-passage. A portion of food may do this, or a coin, or other article which has been held in the mouth. Besides the sudden obstacle to breathing, there is commonly violent spasmodic cough due to irritation of the air-passages by the presence of the foreign substance, which may ultimately cause expulsion of the substance. Sometimes a mass of food will stick in the upper part of the gullet, causing violent effort to swallow or expel it, without at the same time seriously impeding the passage of air. But the feeling of its presence causes great agitation to the person, especially a child or young person, from the fear of suffocation. One must not mistake this state of terror for a state of threatened suffocation. In such cases one can easily perceive that there is no blueness of the face, no swollen state of the veins of the skin, and that the breath can be drawn in and expelled with comparative ease and fulness. The patient must be calmed, assured that there is no danger, and steps may then be quietly taken either to push the mass down into the gullet or to hook it out with the finger. The author remembers vividly a young man who had been eating a sandwich, a bite of which had stuck not at the back of the throat at all, but in the gullet, a short distance down. Owing to its position it pressed forward on to the box of the windpipe in front, and produced the sensation of being in the upper part of the windpipe. The youth was in such a state of excitement and alarm as to make it difficult to assist him. His face, however, but for his terrified appearance, was natural and his breathing free. He was ordered to keep still, and to notice with what ease he continued breathing; and he thus became aware that no serious danger existed. He realized that he was quite safe from risk of suffocation, became quite quiet, and without further trouble a stomach-tube was passed down the gullet and the offending mass pushed safely into the stomach. But if the face becomes quickly swollen and livid, it is clear that suffocation is near, and immediate steps must be taken to avert it. Let the mouth be widely opened and kept from closing by something placed between the teeth, a thick cork, a piece of wood. This is necessary, to prevent the operator's finger being bitten. Then let the operator pass his forefinger through the mouth to the back of the throat. The finger should be passed in away to the side, the cheek being stretched as much as possible. This enables the finger to reach well down the throat. The finger is then swept round the throat in search of the obstruction, which it removes by being insinuated behind and beneath it. If this failed to relieve the person, a surgeon would open the windpipe by the operation of tracheotomy (p. 270), an operation which, in cases of simple obstruction, would relieve even at the very last moment. In the case of children the obstruction may sometimes be dislodged by holding the child up by the heels and smartly slapping the back between the shoulders with the flat of the hand.

In many cases where the breathing is much obstructed swallowing is still quite easy, and the expulsion of the obstacle may be effected by the action of vomiting. This is induced by a tea-spoonful of mustard in a tumbler of tepid water, or by copious draughts of lukewarm water, or by tea-spoonful doses of ipecacuanha wine.

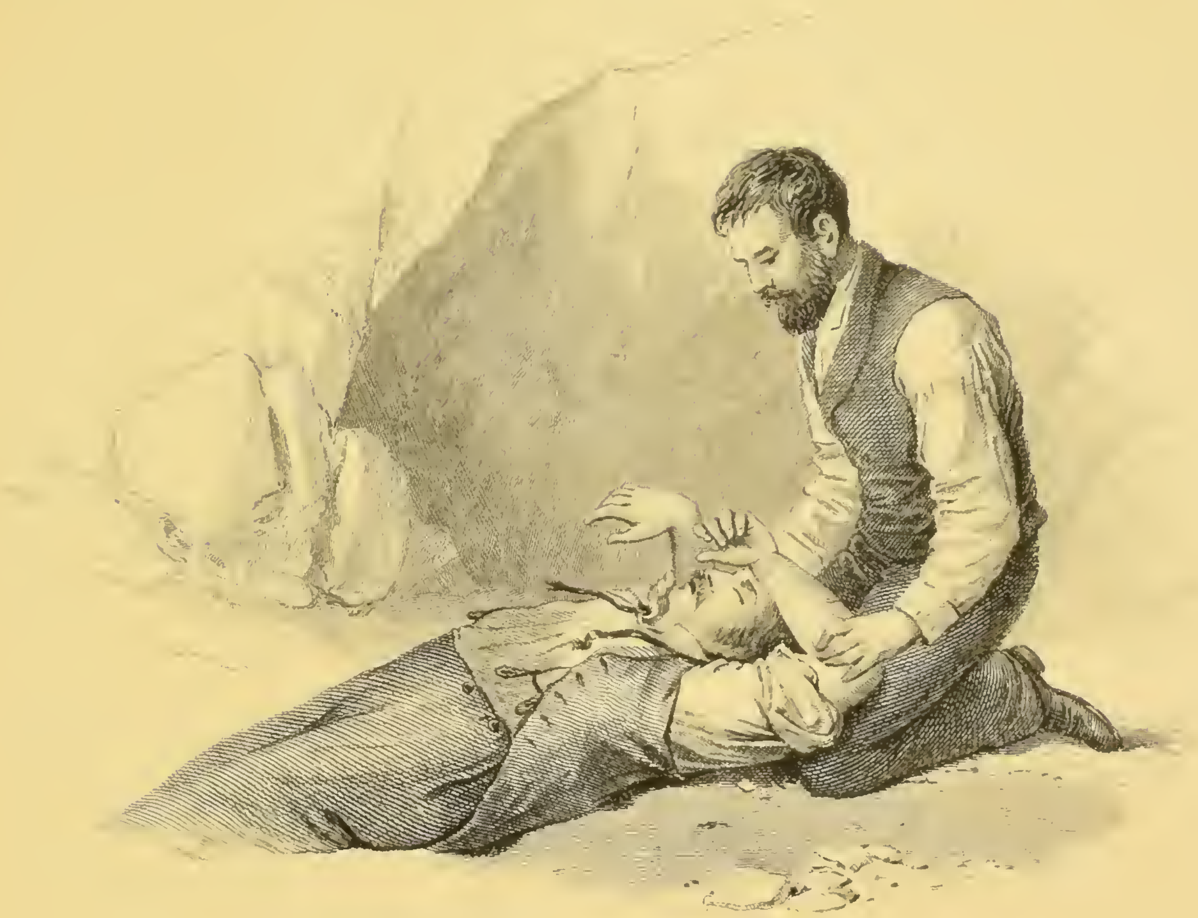
Should ordinary measures fail, should a surgeon not be obtainable in time, is the person to be allowed to die because no skilled assistance is at hand? Surely not! In such an emergency let some person, sufficiently cool and collected, take a pair of sharp fine-pointed scissors, perfectly clean. The scissors must not be too thin in the blades. Lace scissors are too fine. Let him grasp them firmly, *closed*, in his right hand, extending the right forefinger along the *closed* blades to within $\frac{3}{8}$ths of an inch of their points, and keeping it firmly pressed there to act as a stop. Let the patient be stretched out flat on his back, head thrown back, and let the operator lay his left forefinger on the front of the neck, just under the chin, and carry it down the front of the neck in a straight line till he feels the upper border of the larynx—Adam's apple. Let him carry his finger down the middle line of this prominence, pressing his finger point firmly on it, and a little way down his nail will slip into a little oval space between the lower edge of this upper part of the box of the windpipe and the succeeding gristly ring, the space marked o in Fig. 134, p. 262. At this point, only the skin and fatty tissue beneath it and a thin membrane covering over the space are interposed between the fairway of the windpipe and the outside. Keeping the left forefinger firmly pressing on this place to mark its exact site, an act attended with a little difficulty, for the box of the windpipe will be violently forced up and down with the convulsive efforts to breathe, the operator steadily pushes the scissor points through skin and membrane till they penetrate into the windpipe; the right forefinger acting as a stop ensures that they are not passed too far. The instant they have penetrated, a hissing noise, the noise of issuing air, will proclaim the fact, along with some frothy and bloody fluid. But the person must not be alarmed. He must, then, slowly separate the blades of the scissors, so as to enlarge the wound and keep it open, doing so until the air enters and issues freely. He must keep the scissors steadily in that position, being on guard lest they slip out owing to a convulsive cough or heave of the patient, or lest they be accidentally thrust farther in; and in this position he must keep them till a surgeon arrives. If struggle has ceased before the scissors have opened into the windpipe, and no effort of breathing be made by the patient, someone else must practise artificial respiration while the operator keeps the wound open. With no one to help him, the operator might yet keep the scissors in position with one hand and, by pressing heavily on the chest with the other and then removing the pressure, produce respiration to some extent.

If a coin has slipped into the windpipe it will commonly not completely block the passage, so that the necessity of extreme haste is not so great. But it produces violent spasms of coughing whenever it comes up near the box of the windpipe. Place the person flat on a

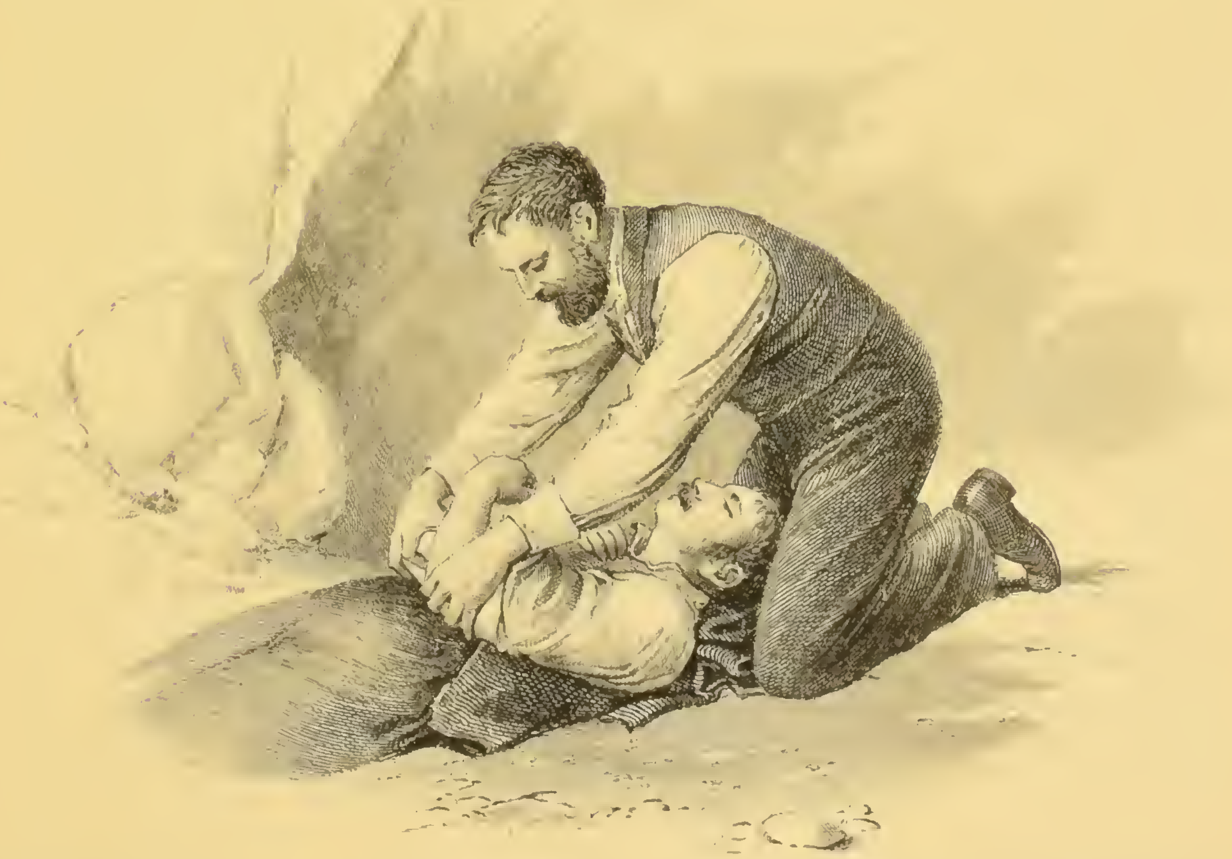
RESTORATION OF THE APPARENTLY DROWNED OR SUFFOCATED.

SILVESTER'S METHOD.

PLATE [illegible]



The movement by which air is made to enter the lungs.



The movement by which air is expelled from the lungs. The double movement should be carried on regularly at the rate of 15 times per minute, and should be persisted in for an hour where the slightest hope of restoration exists.

couch which is easily lifted. Let someone hold him there so that he will not slip off, and let another suddenly lift the foot end high up so that the head is quickly brought to a low level. The coin may roll down the windpipe and out by the mouth. If not it will tickle the larynx and produce the storm of coughing. Bring the couch down to the horizontal, and, in a little time, repeat the manœuvre. If after patient effort this fails, an operation for extraction of the coin by opening the windpipe will be necessary.

Hanging, when there is no marked drop, produces death by suffocation. In the case of hanging as a capital punishment the noose is so arranged, and the length of drop so proportioned to the weight of the individual, that the sudden jerk, produced when the bolt of the platform on which the condemned man stands is drawn, causes dislocation between the first and second vertebræ of the neck and consequent destruction of the nerve-centres presiding over the action of the heart and lungs, so that death is instantaneous and with little or no struggle. But when a person hangs himself, death is by strangulation, the pressure of the rope compressing the windpipe. If any indications exist to suggest that a person found hanged is not quite dead, he should be immediately cut down and the noose unloosed or cut. The fingers and thumb grasping the windpipe where the pressure has been may re-establish the fairway of the tube if the pressure has obliterated it. Then artificial respiration should be performed by Howard's or Sylvester's method, friction should be applied or hot sponges over the heart, and if the patient revives some warm stimulant given.

Strangulation by whatever means is to be treated as directed for Hanging.

SECTION VI.—WHAT TO DO IN CASES OF POISONING.

- Classification of Poisons:
  - *Corrosive and Irritant, Narcotic, and Narcotico-irritant Poisons.*
- Symptoms of Poisoning:
  - *Symptoms of Corrosive and Irritant Poisoning;*
  - *Symptoms of Narcotic Poisoning;*
  - *Symptoms of Narcotico-irritant Poisoning.*
- General Treatment of Poisoning:
  - *Emetics and Antidotes.*
- Corrosive and Irritant Poisons:
  - *Acid Poisons*—Hydrochloric, Nitric, Sulphuric, Carbolic, Acetic, and Tartaric Acids;
  - *Poisoning by Caustic Alkalies*—Soda, Potash, Saltpetre, and Ammonia;
  - *Metallic Poisons*—Antimony, Arsenic, Lead, Mercury, Tin, Zinc;
  - *Poisoning by Iodine and by Phosphorus and Lucifer Matches.*
- Poisoning by Alcohol.
- Narcotic and other Nerve Poisons:
  - *Opium and Morphia Poisoning;*
  - *Chloral Hydrate and Chlorodyne;*
  - *Hydrocyanic or Prussic Acid;*
  - *Aconite Poisoning;*
  - *Atropine and Belladonna Poisoning;*
  - *Calabar Bean (Physostigmine), Cannabis Indica (Indian Hemp), and Stramonium (Thorn-apple);*
  - *Nux-vomica and Strychnine Poisoning; Poisoning by Paraffin-oil.*
- Poisoning by Vegetable and Animal Irritants:
  - *Aloes, Castor-oil Seeds, Croton-oil, Colocynth;*
  - *Elder Leaves and Flowers, Gamboge, Hiera-picra, Podophyllum;*
  - *Arum maculatum (Lords and Ladies); Camphor; Cantharides (Spanish-fly);*
  - *Cocculus Indicus;*
  - *Digitalis; Hellebore, Veratria, and Sabadilla;*
  - *Hemlock Poisoning;*
  - *Laburnum; Lobelia (Indian Tobacco);*
  - *Meadow Saffron (Colchicum); Nightshade; Privet Berries; Pulsatilla and Poke Berries;*
  - *Tobacco; Turpentine; Virginia Creeper; Yew Berries;*
- Poisonous Clothing, Wall-papers, Hair Dyes, and Cosmetics.
- Poisonous Food.

Classification of Poisons.—Poisons are substances which are capable of acting injuriously on the body and destroying life, either by their direct chemical action on the part to which they are applied, whether external or internal, or indirectly by gaining access to the circulation and acting on the various tissues and organs of the body. This is a very broad way of putting it, but poisons are so numerous and their effects so diverse that it is not easy to define very strictly what a poison is. The Greek word for poison is *toxicon*, and the poisonous effects of a substance are called its toxic effects, while *toxicology* is that special department of science which makes poisons and their effects its study, a toxicologist being one engaged specially in such work. The general definition which has been given of a poison embraces many substances not readily occurring to one's mind when the word poison is used. It includes substances not generally thought of as poisons when used in an ordinary way. Thus alcohol is a poison within the scope of the definition, though it only becomes so when used beyond certain limits. But then the dose has nothing to do with the inclusion or exclusion of any substance, for while a single drop of pure prussic acid will cause death, and the $\frac{1}{20}$ of a grain of aconitine, the active principle of aconite (monkshood), 60 drops is the smallest quantity of laudanum known to have caused death in an adult. Then the general definition allows room for the old adage, "What is one man's meat is another man's poison." Certain articles of food act constantly on some people like irritant poisons, notably shell-fish, but also other quite ordinary kinds of food, such as mutton and eggs; and there are now included as poisons certain substances produced in animal food kept for a long time excluded from the air. The exact nature of these substances has not been determined, but the term *ptomaines* has been applied to them, from Greek *ptōma*, a dead body, since it is dead animal matter in a state of decay in which they are produced. Many instances of poisoning arising from the eating of tinned meats are attributed to the production of these substances, not to the introduction from without of any injurious substances. Owing, therefore, to the diverse character of poisons there is some difficulty in arranging a suitable classification. One might consider their chemical constitution and arrange them accordingly, for example into those belonging to the class of inorganic substances, and those belonging to the class of organic substances. The inorganic substances might be further subdivided into poisonous gases, such as carbonic acid gas, carbonic oxide, sulphuretted hydrogen, &c.; acids, such as nitric, sulphuric, hydrochloric; metals, such as lead, arsenic, mercury, antimony; and non-metals, such as phosphorus. Belonging to the organic class are opium, chloral, alcohol, prussic acid, strychnine, belladonna, which it would be difficult still further to subdivide. It is clear that any such classification would be of no practical use. If poisons could be arranged into well-defined groups, according to their effects upon the body, each poison of one group exhibiting more or less similar symptoms to the others of the same group, and similar treatment being required for all the poisons of one group, then such a classification would be of the greatest possible benefit, because it would simplify the recognition of the kind of poison used in any particular case, and a knowledge of the principles of the grouping would be almost equivalent to a knowledge of the mode of treating any cases that might arise. Such a classification has been attempted, but only in a very general way, for the great diversity of action of the different poisons makes it impossible to effect it more accurately. Moreover, marked differences in the effects one and the same poison produces on the body are observed corresponding to the quantity of poison administered, its state of concentration or dilution, and the condition of the individual at the time of partaking of it. For example, the mineral acids given in their concentrated form produce, immediately on being swallowed, painful burning sensations in mouth, gullet, and stomach, and by their powerfully corrosive action destroy the tissues with which they come into contact, so that death speedily arises, while one of the same acids given largely diluted would have none of these caustic effects, though remote effects on other organs might follow. Then again, the same dose of one poison, oxalic acid, for example, if given in concentrated solution, will produce signs of irritation and inflammation of the mouth, gullet, and stomach; but if given diluted with a large quantity of fluid or other liquid will produce no such symptoms, but in a brief time will cause death through its effects upon the heart and nervous system. If, then, we indicate a grouping of poisons according to their effects upon the body, it must be understood that such a classification is not by any means complete. This classification is one commonly used, and it includes at any rate the most of the poisons commonly known; it is the grouping into the two classes of **irritant or corrosive poisons** and **narcotic poisons**. Irritant poisons are those which set up irritation or inflammation of the throat, gullet, stomach, and bowels, which irritation is readily recognized by the symptoms

THE RESTORATION OF THE APPARENTLY DROWNED.

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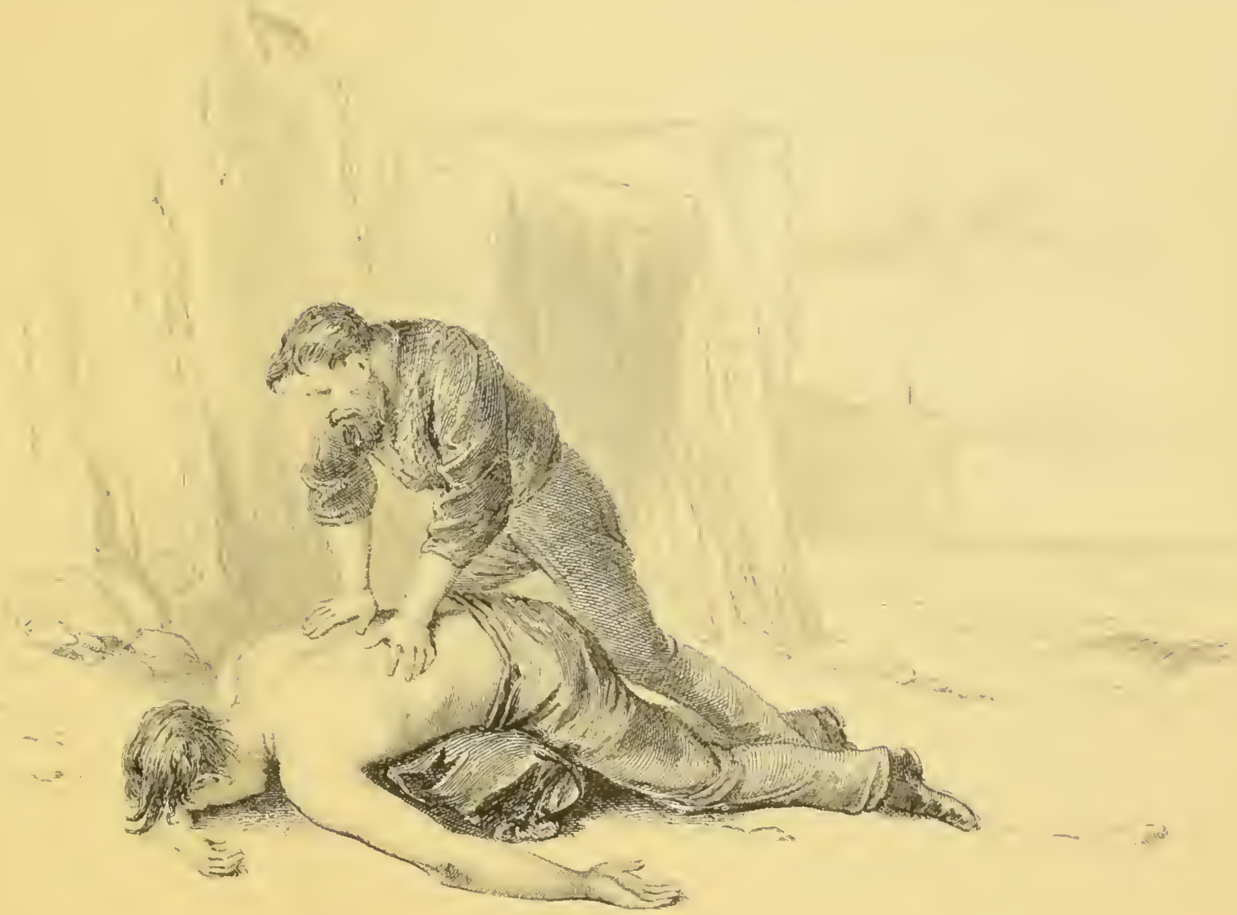

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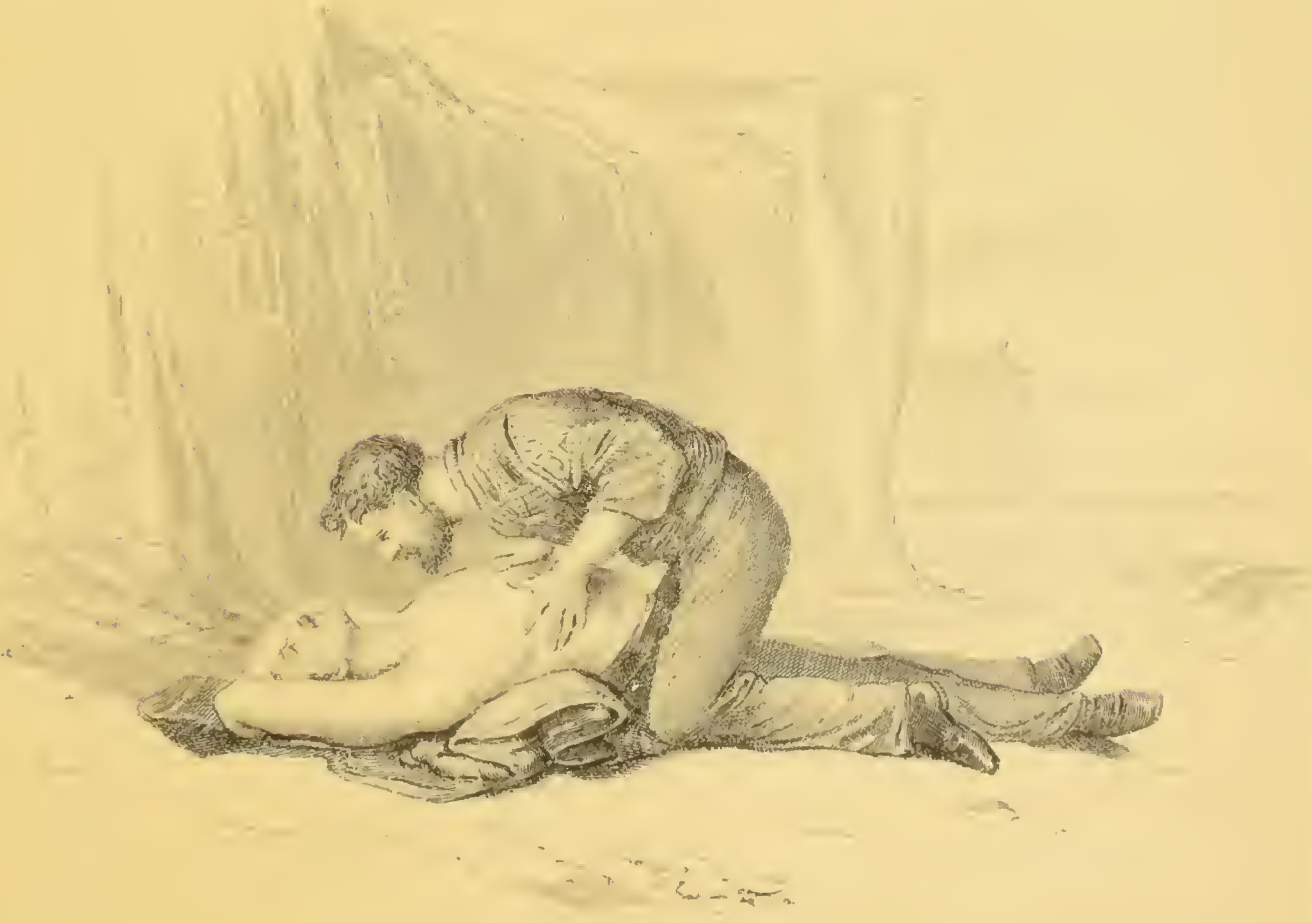

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about to be described; and narcotic poisons are those which act upon the nervous system, inducing paralysis of the brain, insensibility, stupor, and death.

Symptoms of Poisoning.—Stevenson says that the general symptoms which should excite a suspicion of poisoning are the sudden onset of serious and increasingly alarming symptoms, in a person previously in good health, especially if a prominent symptom be pain at the pit of the stomach; or where there is complete prostration of the vital powers, a cadaverous expression of the countenance, an abundant perspiration, and speedy death. Now we have not quoted these sentences from Stevenson in order to indicate that, when such symptoms arise, the unskilled person is immediately to jump to the conclusion that poison has been at work, but rather as a warning against the coming to such a hasty conclusion. For all these general symptoms that have been noted may arise, and do arise, in cases of natural disease. One has known a man, for example, suddenly seized with intense pain at the pit of the stomach while he was actively engaged, apparently in good health, in the transaction of business. Great pallor, most alarming prostration, immediately occurred, and his countenance bore a look of intense anxiety. Unable to assist himself to the slightest degree, he was conveyed home, and was dead fifteen hours later, having never recovered the state of collapse into which, all in an instant, he was plunged. Now, anyone who had read the sentence, in which have been noted the general symptoms, which should excite suspicion of poisoning, would say, "Here surely is a case which accurately answers to the description—this man must have been poisoned." But no such suspicion ever occurred to anyone. The explanation of the whole case was that the man had suffered from a chronic ulcer of the stomach, of which, however, there had been almost no symptoms, so that he thought himself in average health, but it had gradually burrowed its way through the coats of the stomach; and on the day in question he suddenly slipped his foot, made a quick, strong effort to recover himself, and the sudden strain caused rupture of the ulcer—a tear of the stomach wall—to occur, and to be followed by extensive bleeding, of none of which, however, was there any external sign. The sudden pain was at the moment of rupture, and the intense prostration was the result of the internal bleeding. We wish, therefore, to emphasize as strongly as possible the fact that natural diseases present symptoms utterly indistinguishable in many cases from those of poisoning, at least utterly indistinguishable to an unskilled person, however much aided by the reading of descriptions and the study of authorities. Nay, in many cases it is quite impossible for a medical man, however skilled, to distinguish with certainty between natural disease and poisoning. Whenever his suspicions are aroused, he seeks other evidence, evidence from circumstances in the surroundings of the patient, and chemical evidence derived from examination of vomited matters and so on. Illustrations of this fact could be indefinitely multiplied. In a recent case, which excited great public interest, the evidence of medical experts, experts on the subject of poison, was equally emphatic on both sides of the case, the one maintaining all the symptoms were those of poisoning by arsenic, the other that they were no more than symptoms of inflammation of stomach and bowels. Let no one, therefore, come to hasty conclusions as to the causes of an illness, still less be unwise enough to utter suspicions aloud. If symptoms seem to be suspicious, rather let expert medical aid be immediately summoned, and let the person communicate privately, if need be, to the doctor any painful surmises that may have been aroused.

The symptoms of the two common kinds of poisons—irritant and narcotic—will, if now given, be a sufficient general indication of the nature of symptoms of poisoning; and special symptons will be given in detail in speaking of special poisons, later in the section.

Symptoms of Irritant and Corrosive Poisoning.—The symptoms of irritant poisoning are due to the caustic or burning effect of the poison on the mucous membrane of the parts with which it comes into contact, the lips, mouth, throat, stomach, and bowels—if it reaches that length; and the effects are due to the immediate chemical action of the substance. There is a hot, acrid, burning pain and sense of constriction on lips, mouth, throat, and gullet. The feeling of burning from the gullet downwards to the stomach is very great, and thirst is intense. In the stomach there is a sharp burning pain, which extends more or less all over the belly, and pressure on the surface of the belly produces a feeling of tenderness, and speedily of actual pain. The pain of colic is relieved by pressure. Vomiting occurs, usually quickly, and the vomited matters increase the acrid sensations in the gullet and mouth. At first the material vomited is simply the contents of the stomach, but as the vomiting persists the material becomes bilious and mucous, and later may contain blood, which, however, may not be red in colour, but brown or black by the action of the contents of the stomach. The pain over the belly rapidly increases, and the belly becomes swollen, so much sometimes as to make breathing difficult. The vomiting may be followed by purging, if the poison has reached the bowel, and the motions are watery, frequent, accompanied by painful cramps, and perhaps containing blood. The urine is scanty, passed with pain and difficulty, or not passed at all. If the action of the poison has been quick and powerful the patient may show speedy signs of collapse, in weakness and rapidity of pulse, in short shallow breathing, in cold clammy skin and pinched features; and death may occur in from six to twenty-four hours. If the action of the poison has been less immediately and powerfully active, a stage of inflammatory fever, with flushed face and bounding pulse, may precede the stage of collapse and sinking.

The symptoms vary more or less in detail according to the actual poison. To the class of irritant poisons belong:—

Sulphuric Acid (Oil of Vitriol).
Hydrochloric Acid (Muriatic Acid, Spirit of Salt).
Nitric Acid.
Carbolic Acid.
Oxalic Acid.
Creasote.
Caustic Potash.
Caustic Soda.
Caustic Lime.
Caustic Ammonia.
Arsenic.
Antimony.
Copper.
Lead.
Mercury.
Phosphorus.
Silver.
Zinc.
Croton-oil.
Elaterium.
Gamboge.
Spanish-fly (Cantharides).

While all of these are irritant some are, besides, powerfully corrosive, all the acids, for example, the caustic soda, potash, lime, and ammonia, and corrosive sublimate—a preparation of mercury. In strong solutions they produce immediately destruction of a layer of the mucous membrane of lips, mouth, &c., more or less deep, which is quite visible to the naked eye. In the case of nitric acid it is a yellow stain, in the case of sulphuric it is white, and whitish or brown in the case of hydrochloric; that of carbolic acid is white, while caustic potash and soda produce a white drawn appearance. Nitric, hydrochloric, and sulphuric acids produce also yellow, red, or brown stains on the clothing, when any has dropped upon it. The acids and other caustic substances may be dilute enough not to produce such scars, but yet to occasion the irritating effects, and in the case of the metallic poisons it is the irritating effects alone that are pronounced. In the case of the marked corrosive effects being produced, shreds of the destroyed mucous membrane are vomited with blood more or less altered.

The diseases which are apt to be mistaken for poisoning from such substances are inflammation of stomach and bowels, ulcer of stomach and bowels, colic, and cholera; but when a corrosive substance has been swallowed the marks on lips, mouth, and throat will clear up the nature of the case.

When recovery from the immediate effects of the poison occurs, death may yet ensue from subsequent ulceration and exhaustion, or from constriction of gullet and stomach, resulting from the destruction wrought by the poison and the subsequent process of healing.

The Symptoms of Narcotic Poisoning are best seen in the case of opium, morphia, or laudanum poisoning, where there are drowsiness, passing on to deep insensibility, snoring breathing, livid countenance, cold clammy skin. In some cases—poisoning from belladonna and henbane, for example—there is delirium.

The chief narcotic poisons are:—

Alcohol.
Belladonna.
Chloral Hydrate.
Chloroform.
Conium.
Digitalis.
Hyoscyamus or Henbane.
Indian Hemp (*Cannabis Indica*).
Morphia, Opium, and their preparations.
Prussic or Hydrocyanic Acid.
Stramonium (*Thorn-apple*).

A third set of poisons has been called **narcotico-irritant**, because they produce effects similar to both irritants and narcotics. They excite vomiting and purging like the former, but the symptoms go on to stupor, unconsciousness, convulsions, or paralysis. To this class belongs a very large number of vegetable poisons, including croton-oil, colchicum, laburnum, woody nightshade, and many other substances belonging to the vegetable kingdom, including muscarin, the poisonous active principle of poisonous mushrooms.

Poisons, developed in preserved food, are of this class, the sickness, vomiting, purging, weakness, and exhaustion which arise, some time after the food has been taken, yielding subsequently to symptoms indicating action on the brain and nervous system.

The Treatment of Poisoning.—Later in this section, and under the head of each poison, the appropriate treatment in detail for each kind of poison will be given separately, but it will be well to indicate here the general principles of treatment common to all cases. If the poison has been swallowed it passes into the blood from the stomach. Clearly if it can be removed from the stomach before it has had time to be absorbed into the blood, much of the risk will be removed. There are two ways of doing this:

By the use of the stomach-pump,
By substances which cause vomiting—emetics.

In every case, almost without exception, the removal of the poison from the stomach is the first thing to be done. If treatment be begun immediately after the poison has been taken, this may be so effectual that not the slightest sign of poisoning may arise. The author once had to deal with a woman who had drunk the whole contents of a sixpenny packet of rat-poison (arsenic), and who immediately thereafter confessed what she had done. Treatment was begun within 10 or 15 minutes thereafter, and so effectually was the stomach washed out that not the slightest symptom of any disturbance whatever appeared.

The **stomach-pump** is commonly only in the hands of a doctor, and need not be described in detail here. It consists of a long gum-elastic tube, about the thickness of one's finger. It is passed through the mouth into the throat, being directed well back, and down the gullet to the stomach. A small pump is fixed at the mouth end, and water injected till the stomach is well filled, when, by means of a flute-key arrangement, the action of the pump is reversed, and the stomach emptied again. A single-action pump, however, is not unsuitable, which permits the stomach to be filled but has no arrangement for reversing the action without unscrewing the pump portion. The stomach can, however, be washed out by a much simpler contrivance, a simple gum-elastic tube to which a funnel can be attached at the outer end, and water thus run into the stomach. If, when the tube is full, the end is closed to keep it so, and then bent downwards sufficiently, and the end allowed to open, the tube will act as a syphon and drain off the water till the stomach is empty. The outer end of the tube should then be raised, the funnel adjusted, and the stomach filled again, and afterwards again emptied. For it is not enough to empty the stomach, it should be washed out to prevent any portion of the poison being left adherent to the stomach walls to be afterwards absorbed. In an emergency a stomach-tube can be easily devised out of 6 or 8 feet of ordinary thick india-rubber tubing. It is passed down into the stomach, and a funnel attached to the outer end as already indicated. If no filler can be had the ivory end of a syringe could be attached to the outer end of the tube, and by working the syringe the water can be injected into the stomach.

The only cases in which it is not allowable to use the stomach tube or pump are those in which corrosive poison has been swallowed, as there is great probability of some parts of gullet or stomach being so softened or destroyed that there is risk of the tube being pushed through the wall.

As to **emetics**, a great variety may be used. Those almost always at hand are salt and water, and mustard and water:—two table-spoonfuls of common salt in a tumblerful ($\frac{1}{2}$ pint) of tepid water, or a dessert-spoonful of mustard in a tumbler of water. If that is not effectual in a few minutes it may be repeated. The other common emetics are:

30 grains Sulphate of Zinc in a little water,
30 grains Ipecacuanha Powder in a little water,
2 table-spoonfuls of Ipecacuanha Wine in a little water.

The mustard and water may be given first, the mustard being stimulating besides causing vomiting, and it could be followed immediately by a mixture of 30 grains sulphate of zinc and 30 of ipecacuanha powder. Any one of these is quite safe in the hands of an unskilled person, but tartar emetic or antimonial wine should not be resorted to by inexperienced persons. (Emetics are considered in detail on p. 850.) In the absence of any of these substances copious draughts of warm water are to be given, tumblerful after tumblerful, till vomiting occurs. The throat may be tickled with a feather, or the finger passed down to excite retching.

The second thing to do in cases of poisoning is to endeavour to neutralize any direct chemical effect which the substance might have on the stomach walls. In the case of acids this is done by giving draughts of alkaline substances in water, bicarbonate of soda or potash, magnesia, chalk, whiting, plaster from the wall; and, in the case of caustic potash or soda, vinegar in water, lemon juice in water, &c. It is well not to give the neutralizing substances in great quantities all at once, else the enormous development of gas which would occur might be hurtful, especially if any part of the walls of the digestive canal had been seriously damaged by the poison, but in small quantities frequently repeated.

A third step to take is to protect the walls of the stomach as far as possible from the action of any irritating agent, by drinking freely of bland fluids, like white of egg beat up in water, gum and water, oil, milk, &c.

All these steps have for their object protection of the mucous membrane from direct action of the poison. But if the poison has been taken some time before treatment was commenced, some of it must be already absorbed into the circulation, and will not be reached at all by these measures. Nevertheless even though the poison has been taken some time before, it is well to empty and wash out the stomach, in one way or another, for although the whole of it cannot be recovered, it may not be all absorbed. Some of it may yet be lurking about the coats of the stomach, and if allowed to remain will gradually be absorbed, intensifying all the symptoms. The stomach, therefore, ought always to be washed out to prevent this. Again, there are many ways in which poison may gain entrance to the body besides by the mouth and stomach. The poison may have gained entrance by the skin, it may have been rubbed in with liniment or ointment, or it may have gained entrance by a wound, or it may have been administered by hypodermic injection. In all these cases cleaning out the stomach can have no effect on the poison already circulating in the blood. For such cases it is necessary to employ an antidote, if an antidote be known for the particular poison.

Antidotes (Greek, *antidotos*, a remedy) are substances which counteract or prevent the action of a poison. This they may accomplish in the stomach before the poison is absorbed. Thus if snake poison be mixed with a solution of permanganate of potash, it ceases to have any poisonous effect; if white of egg and corrosive sublimate (perchloride of mercury) be mixed, an albuminate of mercury is formed, which is insoluble and cannot be absorbed; arsenic and iron form an insoluble compound, and so a solution of freshly prepared oxide of iron is given in arsenical poisoning. In such cases it becomes necessary to wash out the stomach, after the antidote has been given, to expel the now insoluble poison. But some antidotes also act by producing on the various organs of the body effects which counteract those produced by the poison. Substances are, therefore, given which follow up the poison in the blood and prevent it producing its usual results. Substances which thus hinder one another's effects are said to be **antagonistic drugs.** Thus belladonna is an antidote against opium poisoning, and, of course, opium to belladonna poisoning, chloral hydrate is to some extent an antidote to strychnine. In cases of poisoning, then, besides washing out the stomach, or exciting vomiting, giving substances to neutralize any corrosive action, supplying bland and soothing substances to the stomach, it is necessary to administer, if possible, an antidote to the poison.

Besides the various steps that have been related, others must be taken, varying according to the circumstances of the case. The person should be kept warm by means of warm clothing, warm rubbing, &c. If shock has been produced, if the heart and breathing are feeble, the skin cold and pale, the general treatment described under Shock, p. 990, must be undertaken. Again, if the person be drowsy, every effort must be made to arouse him—douches of cold water are useful for this purpose, stimulants may be necessary, and commonly are. Hot coffee is one of the best, but hot alcoholic stimulants may be advisable.

POISONING BY CORROSIVE SUBSTANCES—ACIDS — CAUSTIC ALKALIES — LUNAR CAUSTIC—IODINE AND PHOSPHORUS.

Poisoning by Corrosive Acids.—These acids are:—

Hydrochloric Acid or Spirit of Salt or Muriatic Acid,
Nitric Acid or Aqua Fortis,
Sulphuric Acid or Oil of Vitriol,
Carbolic Acid, Phenic Acid or Phenol,
Acetic and Tartaric Acids.

The symptoms of poisoning by these acids have been already described under irritant poisons on p. 1015. They are, briefly, immediate burning pain in mouth, gullet, and stomach, great thirst, vomiting of intensely acid material, the food vomited being mixed with altered blood. Inflammation of the bowels arises and the belly becomes swollen and tense. There is likely to be constipation and suppression of urine. The stain in the mouth is yellow in the case of nitric acid, brown in the case of hydrochloric, and white in the other cases. The shock is marked by weak pulse, and cold clammy skin; difficulty of breathing and swallowing are marked. In the case of carbolic acid the urine becomes dark, even black in colour. A similar dark-coloured urine is sometimes passed in surgical cases, owing to absorption of the carbolic acid used for the dressings, but it is not usually attended by other symptoms.

In the case of each of the strong acids one to two tea-spoonfuls can prove fatal, but recovery has followed the taking of even half an ounce.

Treatment.—(1) Do not attempt to use the stomach-pump, nor to induce vomiting; the damage to the parts may be so great that this would be accompanied by risk.

(2) Give immediately large quantities of water to dilute the acid, containing also some alkaline material to destroy the acid. Soapy water, water with bicarbonate of potash, bicarbonate of soda, common washing soda, magnesia, ammonia, chalk or lime water, whatever of this kind is at hand, will suit.

(3) Follow up this with bland drinks which will soothe the corroded membrane, white of egg drink, gummy water, milk, oil freely, and so on.

(4) Maintain the warmth of the body, restore the patient from shock (see p. 990), and subsequently give nourishing and stimulating food.

In the case of carbolic acid Epsom salts or Glauber's salts are to be given—$\frac{1}{2}$ ounce in $\frac{1}{2}$ pint of warm water. They form sulpho-carbolates with the acid, which, though absorbed, are harmless. Large quantities of Epsom salts or Glauber's dissolved in tepid water may be used to wash out the stomach, and the other treatment is the same.

Oxalic Acid Poisoning.—Oxalic acid or the oxalate of potash—salts of sorrel—is sometimes taken by mistake. It produces symptoms identical with those of the corrosive acids named, and it may cause death within ten minutes of its being taken. Besides the corrosive effect it has a powerfully depressing action on the heart, causing feeble pulse and excessive languor, and it is these nervous effects that cause the speedy death.

A quarter of an ounce has killed, but recovery from twice that quantity has occurred.

Treatment.—(1) Give freely chalk, lime, or whiting. The lime or whitewash from walls may be used, lime-water also, or tea-spoonful doses of the saccharated solution of lime frequently repeated. These lime preparations form insoluble salts with oxalic acid, but soda, potash, magnesia, ammonia form soluble salts, and are to be avoided.

(2) Give an emetic to clear out the stomach after the lime draughts.

(3) Clear out the bowels with an ounce of castor-oil.

(4) Maintain warmth; and supply stimulants, if necessary.

Acetic Acid.—Glacial acetic acid would cause corrosion like the acids already named. Cases of poisoning are to be treated exactly as those of the other acids.

Tartaric Acid has been taken in mistake for a saline medicine, and one ounce of it has caused death. The symptoms are great pain in the abdomen, convulsions, collapse, and death.

Treatment.—Large draughts of water containing lime, whitewash, or whiting should be given, or tea-spoonful doses, frequently repeated, of saccharated solution of lime. Soda, potash, and ammonia are to be avoided. The bowels are then to be cleared out by a full dose of castor-oil.

Poisoning by Caustic Alkalies (Soda and Potash).—Solutions of these caustic substances are sometimes taken by mistake. The impure carbonate of potash—pearl ashes—used for cleaning may be accidentally taken, and caustic lime may be similarly swallowed. In such cases loose stools, purging, bloody motions are the rule, while in the case of acids it is constipation. Otherwise the symptoms are similar to those produced by corrosive poisons.

Treatment.—(1) Do not use the stomach-pump, but give copious draughts of water, vinegar and water, acetic acid in water, orange lemon or lime juice, citric or tartaric acid in water, and so on, to neutralize the soda or potash, and give such in small quantities frequently repeated—repeated every few minutes.

(2) Subsequently give the bland drinks of gummy water, white of egg drink, olive-oil, &c., as directed for acids.

Saltpetre or Nitre (*Nitrate of Potash*) may cause fatal poisoning in a one-ounce dose. The symptoms are those of an irritant poison, with subsequent tremors, convulsions, and death from collapse. In this case use the stomach-pump or an emetic, and then use warmth and stimulants to ward off the shock, giving bland drinks also as before.

Ammonia, in addition to producing effects akin to caustic alkalies, acts upon the lungs and air-passages, producing suffocative cough, often loss of voice, and sometimes death by the irritation of lungs and air-tubes. In addition to the treatment advised for soda and potash, employ inhalations of steam. An operation may be necessary to relieve the breathing if the swelling at the top of the windpipe be very great.

Lunar Caustic sometimes accidentally passes down into the stomach when being used for touching an inflamed throat. It is a preparation of silver—nitrate of silver, but it may be well to consider it here, alongside the other caustic substances. Symptoms of irritant poisoning are produced, pain, vomiting, &c., and the vomited matter is of a flaky white appearance, and turns brown or black on exposure to light.

Treatment.—(1) Give large draughts of common salt dissolved in water. This forms with the caustic the insoluble chloride of silver.

(2) Then give an emetic, ipecacuanha (20 grains), sulphate of zinc (20 grains) or mustard in water, to empty the stomach.

(3) Soothing drinks, oil, gummy water, white of egg in water, barley-water, are then to be supplied.

Iodine, a non-metallic element, occurring in crystalline scales, may be most conveniently considered in this group. It may be taken in the form of the scales, by mistake for another substance, or as the solution—tincture of iodine. Symptoms of irritant poisoning are produced, and faintness, giddiness, and convulsions may occur. Iodine strikes a blue with starch, and the vomit may consequently be blue.

Treatment consists in (1) the use of the stomach-pump, or an emetic of mustard (table-spoonful) in a tumbler of water, or 20 grains of sulphate of zinc or ipecacuanha powder in water.

(2) Give freely drinks of starch and water, arrow-root, white of egg, gruel.

(3) Apply poultices over the stomach to relieve pain.

The effects produced by excessive doses of iodide of potassium are called **iodism**, and are described on p. 825.

Phosphorus poisoning may arise from the solid phosphorus, from the use of rat paste—phosphorus paste—in children from the sucking of lucifer matches; and chronic cases are frequent from the inhalation of phosphorus fumes in match manufactories.

Symptoms of irritant poisoning, colicky pains, vomiting, diarrhœa may be more or less marked. The vomited matters, sometimes the urine, are luminous in the dark; and the breath has a peculiar garlicky odour. The liver is specially affected, is tender, and enlarged, and in a few days jaundice occurs; the urine is scanty, high-coloured, and contains bile. There may be bilious vomiting; there is headache; and the patient is dull and sleepless, perhaps in muttering delirium, with weak, fast pulse, death occurring in from two to ten days of exhaustion. The dose which will produce such effects is about ½ grain. Sometimes there is a marked tendency to bleeding, the vomit and stools being bloody, bleeding from the nose occurring, and bleeding taking place in the skin producing the appearances of bruising. In other cases nervous symptoms are most pronounced, mental failure, prostration, convulsions, and stupor. One marked result in chronic cases is decay of the teeth, and death (necrosis) of the lower jaw-bone.

Treatment.—In acute cases (1) give an emetic of 20 grains powdered ipecacuanha or sulphate of zinc in water.

(2) Give 10 to 20 drops of oil of turpentine, frequently repeated (every half hour for a time)—the French oil of turpentine specially.

(3) Give ½ oz. Epsom salts as a purge.

(4) Administer in plenty gummy drinks, *but no oils,* as they dissolve the phosphorus and make it more readily absorbed.

Poisoning by Lucifer Matches is to be similarly dealt with.

METALLIC POISONING.

The metals which most frequently give rise to cases of poisoning are:—

Antimony,
Arsenic,
Copper,
Lead,
Mercury.

The symptoms they produce are generally those of an irritant poison (p. 1015).

Antimony—Tartar Emetic.—Tartar emetic produces speedy and violent vomiting, and poisoning by one large dose is comparatively rare, since the expulsion of the poison from the stomach is quickly secured. The vomit is at first of food; then it becomes bilious, and finally tinged with blood. There is pain in the abdomen; a metallic taste is felt in the mouth, and a burning pain and feeling of constriction, extending to the throat and gullet. Just preceding the vomiting there is intense prostration, and faintness, accompanied by weak pulse and feeble breathing, while the skin is cold and bathed in a cold perspiration. Later the bowels become affected and a copious watery discharge comes from them, resembling the rice stools of cholera, while the urine becomes scanty and may be suppressed. The patient is excessively weak, muscles are relaxed, and cramps of the extremities sometimes occur.

A single large dose may or may not prove fatal according to the rapidity with which vomiting occurs. But recovery has occurred after half an ounce had been taken, though 10 to 20 grains would likely cause death in a few hours; and 2 grains have proved fatal; while three-quarters of a grain have killed a child.

Much smaller quantities than those named will cause death if they are given in small frequently-repeated doses. Similar symptoms occur—prostration, sickness, vomiting, purging, profuse perspiration, impaired breathing, feeble pulse; and death occurs by exhaustion. The symptoms have marked resemblances to cholera states and conditions of chronic catarrh of the bowels. Sickness, vomiting, and purging also occur in cases of arsenical poisoning, but without the intense prostration and profuse sweating characteristic of tartar emetic.

Treatment.—(1) Emetics are not needed, but, if it can be done, washing out the stomach with the syphon-tube will be advantageous.

(2) Tannic and gallic acids form insoluble preparations with tartar emetic; therefore give half a tea-spoonful of either of these in water, and repeat it if it be vomited. Substances containing tannin will also be valuable as substitutes—decoction of oak bark, tincture of cinchona, strong tea infusion, coffee, and these should be given in large quantities till vomiting ceases.

(3) Thereafter give soothing drinks—egg drink, barley or gum water, arrow-root, &c.

(4) To overcome the depression give stimulants, hot, in small quantities repeated, and maintain the patient's warmth by hot bricks, hot drinks, &c.

(5) Nourishing and stimulating injections may be given (p. 873) if the patient seems to be in risk of collapse.

Arsenic.—Poisoning by arsenic, whether by a single large dose or by repeated small doses, whether the poison be given by the mouth or in any other way, exhibits signs of irritation of the stomach and bowels. In the case of large doses the symptoms are acute, and the patient dies within from eighteen to seventy-two hours of the administration. Within half an hour or an hour of the drug being taken, depression comes on; and a severe burning pain is felt at the pit of the stomach, which is increased by pressure on that region. Vomiting next occurs, at first only of the contents of the stomach; but it persists in spite of the stomach being emptied, and bile appears in the vomit owing to the retching; and sometimes the material is streaked with blood. There is also purging, accompanied by pain and violent straining at stool, and blood may appear in the motions. The throat is dry and burning; and thirst is great. The depression and faintness are marked; the skin is cold and clammy; pulse weak and irregular. There may be retention of urine; and a rash may appear on the skin. In cases of chronic poisoning there are loss of appetite, sickness and vomiting, a feeling of tenderness at the pit of the stomach, thirst, dryness of the mouth, redness of the lining membrane of the nostrils, puffy eyelids and reddened eyes, silvery-looking coating on the tongue, headache, irritability of the bowels manifested by frequent slimy motions perhaps mixed with blood, muscular weakness and sometimes even paralysis, beginning with the legs, dry irritable scaly skin, and steady loss of flesh. Death usually occurs by exhaustion.

Death has occurred from 2½ grains of arsenious acid—white arsenic—contained in 2 ounces of fly-water, and from ½ ounce of Fowler's solution of arsenic, which is equal to 2 grains of white arsenic, and death may occur, owing to exhaustion, from a single large dose many days after its administration.

The chronic forms of arsenical poisoning, while they may result from the frequent administration of small quantities, may also be due to the inhalation of dust from fabrics coloured by arsenical dyes, especially green, and to vapour of the poison from other articles. Thus arsenical pigments are to be found in articles of dress, in wall-papers, in artificial flowers, floor-cloths, book-bindings, &c., and it is to be remembered that many fly-papers and rat poisons contain arsenic.

Treatment.—In acute arsenical poisoning—

(1) Ensure thorough emptying of the stomach, and, if possible, washing out of the stomach. This is best accomplished by the stomach-pump or syphon-tube. Failing these, give mustard and water (a table-spoonful of mustard in a tumbler of water), or sulphate of zinc (20 grains) in water, and administer

copious draughts of hot greasy water, salt and water, effectually to clear out the stomach.

(2) Give as an antidote the hydrated peroxide of iron. This is prepared by adding half an ounce of carbonate of soda to an ounce of liquor of the perchloride of iron, or the ordinary tincture of steel. This should be strained through a handkerchief and diluted with hot water. Unlimited quantities may be given. Failing this, repeated doses of one ounce of dialysed iron should be given, or repeated doses of magnesia.

(3) Gummy drinks, barley-water, white of egg and water, linseed tea, should follow the antidote.

(4) Prostration is to be overcome by the free use of stimulants, and by the maintenance of the warmth of the body.

(5) Large doses of castor or olive oil, or a mixture of oil and lime-water, should follow up the above procedure.

In cases of chronic poisoning let the source of poisoning be discovered. Let the wall-paper be examined. Arsenic is not confined to green wall-papers. If the cause cannot be found and removed, let the person seek change of air. The use of quinine and iron tonics and warm baths will promote recovery.

Copper.—Blue-stone, or blue-vitriol, is the sulphate of copper, and verdigris the subacetate of copper. In the case of either of these being accidentally or intentionally swallowed, symptoms of irritant poisoning arise—a metallic taste in the mouth, thirst, sense of constriction and burning in the throat, sickness and vomiting, colicky pains, purging with straining, suppression of urine, hurried breathing, quick feeble pulse, headache, giddiness, stupor, perhaps convulsions. Death may take place within a few hours. The fatal dose of either of the compounds named is from half an ounce upwards.

Chronic forms of copper poisoning may occur from the use of pickles coloured green (p. 600) by the metal, by the use of acid fluids which have been in contact with copper vessels, and it may occur among workers in copper or bronze.

In cases of copper poisoning the vomited material has a greenish or bluish colour which becomes bright blue on adding ammonia.

Treatment in acute cases:—

(1) Empty the stomach by the stomach-tube or an emetic, mustard (tea-spoonful) and water, or ipecacuanha powder (20 grains) in water.

(2) Give white of egg switched in water and milk in large quantities to precipitate the copper.

(3) The after administration of barley-water, arrow-root, gruel, in quantity is to be carried out.

In chronic cases the person should be removed from the source of poisoning.

Lead Poisoning.—The acetate of lead—sugar of lead, the carbonate—white-lead, and Goulard's lotion—solution of the subacetate, have been taken by mistake in poisonous quantity. An ounce of either of the two powders is usually recovered from, and three-quarters of a pint of the lotion have not proved fatal, and cases of acute poisoning are rare. The chief symptoms are dryness of throat, thirst, metallic taste in the mouth, colicky pains chiefly in the neighbourhood of the navel, cramps in the legs, marked constipation, paralysis of the legs, and convulsions. It is the chronic cases that are numerous. They are frequent among workers in lead, plumbers, type-founders, compositors, among workers in lead pigments, painters, artists; and they are often due to contamination of water or other liquids, used for drink, by contact with lead pipes, leaden cisterns, leaden vessels, leaden taps. Cider has been contaminated owing to the glaze in the jars containing lead. Glazers of cards and workers in Brussels lace are said to suffer, and lead poisoning has resulted from the frequent use of hair dyes and cosmetics of which some preparation of lead was an ingredient. Shot used for cleaning bottles has contaminated the drink afterwards kept in the bottles. The contamination of drinking water is considered on p. 642.

The two characteristic symptoms of lead poisoning are colic and "wrist-drop." The colic has been termed "painter's colic," "Devonshire colic," from its association with cider, and "colica Pictonum," from the inhabitants of Poictou, among whom lead poisoning was common owing to the use of lead salts for adulteration purposes. The pain occurs about the centre of the abdomen in spasms like colic, and the abdominal wall is hard and drawn in. The pain is relieved by pressure. The bowels are obstinately costive. The patient also suffers from a feeling of sickness; the tongue is coated, the breath foul; and the patient feels a sweetish astringent taste in the mouth. At the margin of the teeth and gums a blue or violet line is developed. The skin has a dull earthy look, and the countenance is anxious. The "wrist drop" is due to a paralysis of the muscles which are situated on the back of the forearm and pull the hand backwards, so that when the arm is stretched out the hand drops and cannot be raised. The paralysis may extend to other muscles of the arm, and to the legs and trunk. Rheumatic pains in muscles and joints are common; irritability of temper, sleeplessness, melancholy, and other indications of affections of nerves occur. Blindness owing to wasting of the optic nerves may arise, and disease of the kidneys is sometimes a consequence. Abortion is common in women.

Treatment.—In acute cases—

(1) Empty the stomach by the pump or an emetic of mustard and water, or sulphate of zinc (20 grains), or ipecacuanha powder (20 grains) given in water.

(2) Give, as an antidote, some sulphate—Epsom salts (sulphate of magnesia) or Glauber's salts (sulphate of soda), half an ounce of either in water, or half a tea-spoonful of dilute sulphuric acid in water. Any of these, with a lead compound, forms sulphate of lead, which does not dissolve and is not absorbed into the blood.

(3) Follow up this treatment with bland drinks, barley-water, milk, white of egg in water.

(4) Poultices to the belly will help to relieve the pain.

(5) Five grains of iodide of potassium in water three times daily will help to get rid of any of the drug which has been absorbed into the system.

In cases of chronic lead poisoning—

(1) Remove the person from the contaminating influence.

(2) Give a purgative, the best being sulphate of magnesia, which may be repeated in one-ounce dose for several successive mornings.

(3) Give iodide of potassium in 5-grain doses, dissolved in water, five times daily, for two or three weeks to remove the lead from the system.

(4) Supply nourishing, easily digested food, cod-liver oil and malt, &c.

(5) Sulphur baths, electricity and massage to the paralysed muscles will aid materially in the restoration to health.

(6) Opium or morphia is often required to relieve the colicky pain. It may be given in the form of suppository.

Precautions against further lead poisoning must be taken. Lead-workers who have been affected will require to change their occupation. As preventative measures, lead-workers should be scrupulous in the matter of cleanliness, changing work-clothes when work is over, washing hands, using tooth-brushes, and so on, in order effectually to remove from their person any dust which may contain lead.

Mercury.—Metallic mercury is almost inactive, if not altogether so, so long as it remains in the metallic state. If some of it has been swallowed, and if, in its course through the intestinal canal, any of it undergoes chemical changes into salts of mercury—the oxide, for example—symptoms of poisoning may arise from the absorption of the salt. The chief poisonous preparation is the perchloride of mercury or corrosive sublimate, which is used in medicine as a drug, and in the preparation of lotions and ointments, and is now very largely used as an antiseptic, so that the opportunities for accident are numerous. Symptoms of poisoning may arise from its use in lotions as a dressing or an injection, and symptoms of poisoning are not uncommon from the use of mercurial ointment, which contains metallic mercury, but in a finely divided state. Calomel, the sub-chloride of mercury, may also give rise to poisoning. There are rare instances of the white and red precipitates causing death, and of other preparations of mercury also.

Of corrosive sublimate 2 to 3 grains are believed to be a fatal dose, though recovery from much larger doses has occurred; and of calomel 12 grains have caused death. In acute cases of poisoning death may occur in a few hours or not for several days.

Chronic poisoning from the inhalation of mercurial fumes occurs among workers in mercury—gilders, looking-glass makers, the makers of barometers and thermometers.

Acute poisoning from corrosive sublimate presents symptoms resembling those due to corrosive acids or alkalies (p. 1015). An intense burning sensation is felt in the mouth and throat, which appear white and swollen where the solution has touched. There is a feeling of constriction in the throat, and great pain in the stomach. Vomiting, painful straining, purging often with bloody motions, occur. The skin is cold, pulse feeble, breathing difficult, and other symptoms of collapse are present. Urine is suppressed and convulsions may occur.

In cases of chronic poisoning one of the chief symptoms is salivation, a constant flow of saliva from the mouth. The salivary glands are swollen and tender, so also are the gums and tongue; the breath is very fœtid; ulceration of mouth and throat may occur. Sickness, vomiting, colicky pains, general tremor of the muscles

—mercurial tremor—emaciation and exhaustion, occur. The trembling affects first the upper limbs, but extends to the rest of the body, and occurs only when the person exerts the muscles.

Treatment.—In acute poisoning—

(1) An emetic of mustard and water, or sulphate of zinc (20 grains), or powdered ipecacuanha (20 grains) should be given.

(2) As an antidote give the white of two or more eggs beaten up with water. The albumin forms with the mercury an insoluble albuminate of mercury. Failing white of egg, give flour made into a cream with water, arrow-root and water, barley-water, milk and lime-water. Then empty the stomach again.

(3) Stimulants may be necessary.

In chronic cases remove the person from the source of poisoning. Give iodide of potassium in 5-grain doses thrice daily, and when salivation is marked let some mouth-wash be used—glycerine and tincture of myrrh and borax, for example. Change of air and tonics are valuable; and for the tremors electricity and massage would be useful.

Silver.—Nitrate of silver or lunar caustic as a poison has already been considered among corrosive substances (p. 1020).

Zinc has been a cause of poisoning in the form of chloride of zinc, which is the active material in Sir Wm. Burnett's disinfecting fluid, one ounce of which contains 230 grains. Its symptoms are those of a corrosive poison, like corrosive sublimate.

Treatment.—(1) Warm solutions of carbonate of soda or carbonate of potash or common washing soda. The substance used must be dissolved in a large quantity of water and given freely. Phosphate of soda in plenty of water is also useful. These substances form insoluble salts of zinc.

(2) Milk and eggs in water, decoctions of oak bark, tannic or gallic acids, and strong tea are also to be given.

Sulphate of zinc (white-vitriol or white-copperas), which is given as an emetic in 20-grain doses, has in large doses caused death its symptoms being those of an irritant but not corrosive poison.

POISONING BY ALCOHOL.

Large doses of alcoholic liquors act like narcotic poisons, and may cause death within a few hours. The distinction between insensibility from alcohol and insensibility due to concussion of the brain, apoplexy, and other conditions is not so easily made as is supposed; and so far as immediate aid is concerned, is unnecessary, for the one case demands as careful attention as the other. The effects of drinking it is needless to state here. When a person lies "dead drunk," the face is usually flushed, though it may be pale, the lips are livid, the eyes red, and the pupils are commonly dilated, both equally, though sometimes they are contracted and unequal. The breathing is slow and snoring—stertorous is the technical word. The pulse is slow and laboured, and the skin pale, clammy, and covered with sweat. The temperature of the body is low, and the muscles are all relaxed. A person in this condition lying exposed to the weather, or even under shelter, but without warm coverings, is in grave danger. The loss of the body heat is greatly hastened by alcohol, as explained on page 673, and the exposure to cold may speedily cause death.

The surroundings will usually assist one to arrive at a decision. The proximity of a whisky bottle, the smell of the breath, and so on are useful guides; but they are not to be taken as decisive. A drunk man may have fallen and received a blow sufficient to cause concussion of the brain or fracture of the skull, and his state may be the combined result of alcoholic poisoning and brain injury. He may have been seized with a fit of apoplexy. Caution in coming to a conclusion is, therefore, necessary; and it is best to treat the person as if the condition were grave. Injuries to the head or other parts of the person should be looked for; if squinting were present, or the face were drawn to one side, indicative of paralysis, serious brain injury should be suspected. In opium poisoning the pupils are much contracted, while, as already said, in alcoholic stupor they are usually dilated and fixed.

Treatment.—In many cases it will suffice to bring the patient under cover, to place him in a comfortable position, to restore warmth by the use of friction to the surface of the body, by wrapping in warm blankets, and placing hot bottles at his feet, and then leaving him to sleep off the effects of his excess. In some cases this is not enough. Much spirit may still remain, unabsorbed, in the stomach to maintain and aggravate the condition, when the power of absorption returns. It is, therefore, customary, when the case is serious, to empty and wash out the stomach by means of the stomach-pump, or by means of an emetic, for which purpose a table-spoonful of mustard in a tumbler of warm water is best for its stimulating properties. Then efforts to rouse the patient should be made. A douche of cold water is wonderfully effective, or flapping the skin with a wet towel; vigorous slapping of the soles of the feet with slippers is often effective when shouting, pulling, and pinching fail. Once roused, the patient should have hot coffee to drink, and if he can be roused enough to take "a good square meal," it has a remarkably sobering effect. Delirium and chronic drunkenness have already been considered on p. 104.

POISONING BY NARCOTICS AND OTHER NERVE POISONS.

Opium, and its active principle **Morphia**, are the chief narcotic poisons, and are responsible for a very large number of deaths annually. The preparations of opium are mentioned on p. 897. Besides laudanum — the tincture of opium—common preparations are nepenthe and chlorodyne, the latter of which contains about 2½ grains of morphia to the ounce, a quantity which has caused death; and it is necessary to remember that paregoric elixir, both the English and Scotch, contain opium as one of their chief ingredients. Children are peculiarly susceptible to the influence of opiates. "It is said on good authority that 15,000 children are killed every year by soothing syrups and other similar preparations" (Murrell). The chief of these are **Dalby's carminative**, which is said to contain about 4 drops of laudanum in each tea-spoonful, and 40 drops have proved fatal to a child; **Godfrey's cordial**, which contains ½ grain opium to each ounce, and against which fifty-six deaths in five years were recorded, the fatal dose for an infant being set down as one tea-spoonful; "Mother's Friend," eight or ten drops of which may be fatal; and **Mrs. Winslow's soothing syrup**, which contains morphia with essence of anise and syrup of balsam of tolu. **Black drop** is a preparation of opium with three or four times the strength of laudanum.

Of crude opium 4 grains have caused death, and the same result has followed from 2 drachms —120 drops—of laudanum. A single grain of morphia has proved fatal. These were cases of adults, but less than ½ grain of opium has killed a child, and 4 drops of laudanum was the cause of death of a child nine months old, while two drops have proved fatal in an infant five days old, and a seven days old child died from the effects of *one drop*. Recovery from large doses, under prompt and vigorous treatment, has often been achieved, and 4 to 6 grains of morphia ought to be recovered from in the case of an adult under good treatment.

Most cases of opium or morphia poisoning prove fatal in from six to twelve hours. A relapse and a fatal termination may, however, occur, after recovery seems to have set in.

The heads of the white poppy, decoctions or infusions of the seeds, leaves, and capsules—poppy-heads, the blossoms and fruit of the red poppy, and syrup of poppies, a sweetened decoction of poppy-heads, have all proved fatal to children, to whom they are not infrequently given as soothing preparations.

The symptoms of opium or morphia poisoning are giddiness, drowsiness, and tendency to sleep, coming on in from half an hour to an hour after the dose has been taken. At the very outset a state of excitement may arise, and a pleasant exhilaration. But if the dose is large this may not appear at all, or very briefly. When the dose is small this may be the main effect, and it is accompanied by wakefulness, and often marked itchiness of the whole skin. Such a state is usually followed by depression, a dull headache, loss of appetite, and a dry mouth. With the larger dose the stage of sleepiness is preceded by headache, a feeling of weight and disinclination for exertion in the limbs, and lessened power of feeling. The face is flushed, and may be dark in colour, and as the poison acts the eyes have a strained feeling, the pupils being much contracted. At first, when insensibility occurs, the person can be roused to answer a question, but immediately drops off to sleep again, and after a time it is difficult or impossible to wake him. As the unconsciousness deepens, the breathing becomes slow and noisy, the pulse faster and softer, the skin pale and livid, bathed at first in warm perspiration, but later cold and clammy. Breathing becomes slower, the intervals between each breath being much prolonged. The pupils are at this time much contracted and motionless. Death arises from failure of breathing, the pulse continuing often at a fairly good rate and moderately strong, even when the breathing seems about to stop.

This condition is distinguished from drunkenness by the pin-point pupils, and the smell of opium is usually marked in the breath.

Treatment.—If the drug has been taken by the mouth (1) it is desirable to remove any from the stomach that may yet be unabsorbed. The stomach-pump is the proper means for this, since emetics often fail, because of the soothing effect already produced on the stomach. If any emetic be given it should be mustard (table-spoonful) in warm water (a tumblerful), or carbonate of ammonia (30 grains) in water.

(2) Give tincture of belladonna (30 drops) in water, or its active principle atropine, $\frac{1}{40}$ grain. The atropine will act more quickly if given by hypodermic injection, and the dose should be repeated every twenty minutes till signs of recovery show themselves.

(3) Rouse the patient by every possible means, shouting at him, pinching him, pulling his nose, by ammonia to the nostrils, flapping over bare arms and chest with a wet towel, or by a douche of cold water over his head. Keep him walking about as actively as possible.

(4) Give draughts of strong coffee or tea.

(5) Artificial respiration (p. 1011) may be necessary.

The Morphia Habit.—Persons who have found it needful to take opium or morphia for prolonged periods, for the relief of pain, become so habituated to the use of the drug that they are able to take ever-increasing doses, without producing more than pleasurable slumbers and relief of pain. Very large quantities thus come to be used in time, and when the need for the drug has passed away the person cannot give up its use without a most distressing struggle. De Quincey took nine fluid ounces of laudanum, equal to 333 grains of solid opium, daily, and other cases are recorded where as much as 16 ounces were taken daily of laudanum. Those who take such daily supplies are miserable, listless, dull, and unable to work until the usual dose has been taken, shortly after which they become lively, bright, and full of energy and life. But, when the effects have passed off, they are left again in a state of despondency and wretchedness. It requires time and patience to break off such a habit; and not many are found capable of it if left to themselves. A person should be placed in charge of nurses, if the habit is to be rapidly and effectually got rid of, and they must act rigidly on the orders given to them, and must be able to resist the commands and entreaties of the patient for his drug. Complete deprivation of the drug at once is advocated by some, strength being kept up by careful feeding, and stimulants if necessary, other symptoms (headache and sickness) being relieved by cold applications and ice to suck, and sleeplessness by warm baths, a single dose only being given if dangerous collapse threatens. Another method, and the one generally adopted, is to diminish the doses by infinitesimal amounts, so that the diminution is not observed by the patient. Meanwhile every effort is made to restore the shattered health of the patient. One of the most important means is by stimulating nourishing foods, cooked with skill. Tonics containing quinine and nux-vomica are to be given, and the bowels should be kept regular. Stimulants may be required. If so, they are to be used with great care, lest one form of indulgence is got rid of, only to yield to another. For sleep, 30 grains of bromide of sodium in water are given at bed-time. Massage and electricity will be valuable additions to treatment; and active occupation is most desirable. The patient, however, must be so constantly watched and supervised that it is impossible for him to obtain a surreptitious dose.

Chloral Hydrate poisoning resembles that of opium in many particulars. Deep sleep comes on quickly, with great muscular relaxation. The face is livid and bloated; breathing is much interfered with, slow and noisy; pulse is weak and quick. The temperature of the body falls to a great degree. The pupils are contracted while the patient is asleep, but, if he is roused, they dilate. Death occurs by failure of the breathing or the heart. Such a result has occurred from a dose of 30 grains, though recovery has taken place after 460 grains had been swallowed.

The treatment is the same as that for opium. The stomach should be emptied by the stomach-pump or an emetic. The heat of the body must be quickly restored by friction, hot bottles, hot blankets; and the patient must be roused and kept awake. Hot coffee is given to drink. The only substance approaching to that of an antidote to chloral hydrate is strychnine, of which 5 to 8 drops might be given by the mouth, or 15 drops of the tincture of nux-vomica. Artificial respiration may be necessary for hours to prevent failure of breathing.

Chlorodyne Poisoning is due to the opium contained in the drug, and the treatment is that of opium poisoning.

Prussic Acid or **Hydrocyanic Acid.**—This in its pure and undiluted state is one of the most deadly and rapid of poisons. A single drop will cause death. The vapour of the poison is also destructive to life. The undiluted acid is not obtainable, but two preparations are in use, the dilute acid of the British Pharmacopeia, which contains 2 per cent of the undiluted acid, and the dilute acid of Scheele, which contains 4 per cent. Twenty-five drops of the latter solution would, therefore, be the smallest fatal dose. Recovery, however, has taken place, under treatment, from 2½ times this quantity. The drug acts with great rapidity, in its concentrated form practically instantaneously. Large doses of the Scheele's acid—3 or 4 drachms—would begin to act within 10 or 15 seconds, and 1 drachm—60 drops—within a minute. The symptoms, in cases where a fatal dose has been taken, are rarely delayed beyond 1 or 2 minutes, and death occurs within 5 or 10 minutes.

Symptoms.—When the dose is not so great as to cause death instantaneously, the symptoms are giddiness, mental confusion, difficult breathing, and slow irregular pulse. Insensibility then comes on, the pupils are widely dilated, the eyes open, fixed and glistening. Breathing is gasping, the effort to breathe out being prolonged. The face is livid, the skin cold and clammy, and violent convulsions may occur. There is often vomiting and involuntary emptying of the bowels and bladder. The jaws are firmly closed and the hands clenched.

Noyau (p. 668) contains prussic acid; **Cherry Laurel Water** and **Oil** owe their odour and active principle to prussic acid, of which the former contains ¼ per cent of the undiluted acid, and the latter about 3 per cent. The kernels of peaches, apricots, almonds, &c., contain the acid, and deaths have occurred from eating them (p. 580).

Cyanide of Potassium, a compound of prussic acid and potash, is much used in photography and electro-plating, and has proved fatal with symptoms of prussic acid poisoning.

Treatment must be very quick and energetic.

(1) Use the stomach-pump or secure vomiting by mustard (1 table-spoonful) in warm water, sulphate of zinc (20 grains), or ipecacuanha wine (two table-spoonfuls).

(2) Give stimulants instantly and freely, ammonia (15 drops) in water, brandy or whisky in water, and let ammonia be inhaled from a handkerchief, or use smelling-salts.

(3) Dash cold and hot water alternately over the head and chest of the person to stimulate the breathing.

(4) Resort to artificial respiration and maintain it steadily.

(5) Atropine has been urged as an antidote, $\frac{1}{50}$ grain injected under the skin to be preferred, or 15 drops tincture of belladonna by the mouth.

Alongside of prussic acid must go the **Essential Oil of Bitter Almonds**, which is from five to eight times as strong as the British Pharmacopeia dilute acid, and 17 drops of which have proved fatal, and the **Spirits of Almonds**, used for almond flavouring, which is about the same strength as the dilute pharmacopeia acid.

Aconite (*Aconitum Napellus*, Plate XIII., Wolf's-bane or Blue Rocket or Monkshood).—All parts of the plant are poisonous. The root has been taken in mistake for horse-radish; eating the fresh leaves has been the cause of children's death; for the plant grows wild everywhere. Medicinal preparations (see p. 834) have occasioned many deaths. The active agent is an alkaloid — aconitia. It is used in medicine chiefly in the preparation of an ointment for neuralgia, and it is the chief constituent in **Neuraline**, an application for neuralgia. Sixty drops of the tincture have proved fatal, though recovery has occurred after larger doses.

The **symptoms** are tingling of mouth, lips, and tongue, and a feeling of warmth at the pit of the stomach. Tingling extends to the whole body, followed by numbness and diminished sensibility of the skin. A feeling of faintness comes on; there is sickness and often vomiting. The heart's beats become weak and lessened in number; the breathing is shallow and infrequent; and deafness and dimness of sight arise. Convulsions may occur; death is due to prostration; but there is no disturbance of the intelligence, and the pupils are dilated.

Treatment.—(1) Use stomach-pump or emetic.

(2) To antagonize the poison give 4 drops solution of atropine by the mouth, or 20 drops tincture of belladonna. If the pulse improves give a second dose in half an hour, or give 20 drops tincture of digitalis, followed in two hours by a similar dose, if the pulse has improved with the first.

(3) Stimulants to be given freely, and the warmth of the body to be maintained.

The person should be kept strictly lying flat.

Atropia and Belladonna Poisoning.—Belladonna, Deadly Nightshade, or Dwale grows wild, and produces berries of a dark shiny colour, about the size of a cherry, marked with a deep central furrow (Plate X.). These berries have been eaten by children, and have even been cooked in a pie. The effects produced by any of the medicinal preparations, or by using parts of the plant, are due to the active principle atropia. Recovery has taken place in the case of a child who had eaten fifty berries; death has been caused by a drachm of the liniment of belladonna, though recovery has taken place after much larger doses. The symptoms are heat and dryness of the throat and mouth, great thirst, absence of saliva, and difficulty in swallowing. The face is flushed a bright scarlet, the eyes are bright and sparkling, and the pupils widely dilated and insensible to light, while vision is blurred. The patient is excited and delirious; there is loss of muscular power. The skin is dry, and there is sometimes a rash like that of scarlet fever; and there is inability to pass water, though a frequent desire to do so. Drowsiness comes on; the breathing is hurried, and the pulse feeble. Convulsions occur, stupor, and death.

Treatment.—(1) Empty the stomach by stomach-pump, or by emetic of mustard, sulphate of zinc, or ipecacuanha.

(2) Administer as an antidote extract of physostigmine, the Calabar bean, of which $\frac{1}{4}$ grain in pill may be given every half-hour for several doses.

(3) Stimulants, whisky, brandy, hot coffee, are to be given freely, and the patient is to be kept warm.

(4) Artificial respiration may be necessary.

The prospects of recovery are always hopeful.

Calabar Bean (see p. 902) in poisonous doses causes loss of power in the legs, prostration, contracted pupils, and death from failure of breathing.

Treatment.—(1) Empty the stomach by the pump or an emetic.

(2) Give as an antidote, 15 drops of tincture of belladonna in water, and repeat the dose every quarter of an hour for four doses, or until the pulse is improved and the pupils dilated.

(3) Give stimulants freely; and maintain breathing if necessary by artificial respiration (p. 1011).

Cannabis Indica (Indian Hemp) produces a species of intoxication like opium. Later a feeling of weight in the legs and intense depression come on, and subsequently sleep and stupor. Treat as for opium poisoning (p. 1025).

Poisoning by Henbane or Hyoscyamus is attended by symptoms similar to those which follow poisoning by belladonna, to which the reader should refer (p. 1027). The root of the plant has been eaten in mistake for parsneps.

Poisoning by Datura Stramonium (Thorn-apple—Devil'sApple—Jamestown Weed).—The leaves of this plant (see Plate XII.) have been mistaken for senna leaves, and a deadly infusion made; children have died of eating the seeds.

The symptoms resemble those of belladonna poisoning, flushed face, fixed dilated pupil, indistinct vision, delirium, convulsions, paralysis, and death. One hundred seeds killed a two-year-old child. Treatment is the same as for belladonna poisoning.

Nux-vomica and Strychnine.—The powdered nux-vomica seeds and their active principle strychnine are used in the manufacture of vermin killers, such as Butler's, Battle's and Gibson's, and thus accidents arise. Thirty grains of powdered nux-vomica have proved fatal, so also have three grains of extract, while of strychnine a half grain to two grains is the fatal dose for an adult, but a child between two and three years of age was killed by a sixteenth part of a grain. In fatal cases death generally occurs within two hours. In one case death occurred in twenty minutes after the poison was taken.

Symptoms.—All preparations of nux-vomica and strychnine have an intensely and persistently bitter taste, and if the drug has been taken by accident, this bitterness will certainly strike the person. The symptoms begin within fifteen or twenty minutes of taking the drug. There is a sense of impending suffocation, restlessness and excitement, a preternatural acuteness of sight, hearing, and taste, twitchings or jerkings of the head and whole body, and then, in an instant, the whole body is seized with a violent convulsion. Every muscle is fixed and rigid, head thrown back, chest fixed, corners of mouth drawn down, and by the rigidity and contraction of muscles the whole body becomes arched backwards, in which case it rests on the back of the head and soles of the feet, like a bow, a position called **opisthotonus.** At this time, owing to the rigidity of the chest, breathing is arrested, and the face becomes bloated and dark; the eyes are prominent and the pupils dilated, but consciousness is not lost. In half a minute or a little more the muscles relax completely, and the patient lies exhausted and bathed in perspiration, the breathing becoming regular, and the lividity passing off. But soon another spasm, perhaps more violent than the first, seizes the person, following the same course, to be succeeded also by another, till death occurs from exhaustion or suffocation. The slightest thing will determine a renewal of the spasm, even a whiff of cold air upon the skin.

Treatment.—(1) Give an emetic of a table-spoonful of mustard in a tumbler of water, or 30 grains of sulphate of zinc in water, or 20 grains ipecacuanha; the stomach-pump is not available unless immediately after the poison has been taken, because of the risk of determining a convulsion.

(2) Give quantities of animal charcoal in water, or 30 grains of tannic acid in water, and a second emetic to empty the stomach.

(3) To lessen the spasms give 30 grains of chloral hydrate along with 60 grains of bromide of potassium, and every fifteen or twenty minutes give additional doses of 10 grains of chloral hydrate with 60 grains bromide of potassium so long as the tendency to spasm exists.

(4) Chloroform or ether inhalation is useful, if one is at hand used to their administration.

(5) It is necessary to keep the person warm and absolutely quiet, every noise of shutting door or sudden sound being liable to determine a convulsion.

(6) Artificial respiration may be needful.

Paraffin-oil (Petroleum, Rock-oil, Kerosene, Mineral Oil). — If such mineral oil has been swallowed, the smell of the breath and vomited matters will indicate it. Great prostration is produced, pain in throat and stomach, thirst, restlessness, and stupor.

Treatment.—(1) Use a stomach-pump, or an emetic of sulphate of zinc or ipecacuanha powder (20 grains) in water.

(2) Give stimulants freely, and keep the patient warm.

Poisoning by Vegetable and Animal Irritants.

Many vegetable substances, used in medicine, when given in excessive doses produce symptoms of poisoning by intense irritation of the stomach and bowels, vomiting, purging, pain in the abdomen, great prostration, weak pulse, moist skin, and collapse.

Such substances are:—

- Aloes,
- Castor-oil Seeds,
- Croton-oil,
- Colocynth,
- Elder Leaves and Flowers,
- Gamboge,
- Hiera-piera, a compound of aloes with canella bark,
- Podophyllum (May-apple or Mandrake).

Treatment should be directed

(1) To remove the substance by emetic of mustard (table-spoonful) in water,

(2) to quiet the stomach and bowels by warm bland drinks, white of egg and water, milk (iced), gummy water, barley-water, and by the use of warm poultices to the abdomen,

(3) to overcome the depression by brandy or whisky or aromatic spirits of ammonia, administered in tea-spoonful doses, frequently, as seems necessary.

(4) Camphor may be given, 10 drops of spirit in milk, every ten minutes, for three or four doses.

(5) If necessary, to relieve pain and stop purging, give 5 to 20 drops of laudanum in water, repeated in an hour, if needful.

Arum maculatum (Lords and Ladies, Cows and Calves, the Parson in the Pulpit, Wake-robin, Cuckoo-pint).—This is a poisonous plant, common in moist hedgerows and shady woods in England. Its bright-coloured fruit (Plate XII.) is a temptation to children. It produces severe irritation of mouth, stomach and bowels, causing swelling of the tongue, vomiting and purging. The pupils are dilated; convulsions and insensibility precede death.

Treatment.—(1) Give an emetic—20 grains sulphate of zinc or 20 grains ipecacuanha powder.

(2) Follow this with a full dose of castor-oil.

(3) Give a large cup of hot strong coffee, and stimulants as well.

(4) Keep the patient warm and relieve the bowel pain by warm poultices.

Camphor (p. 850).—The chief symptoms of camphor poisoning are nervous in character. A species of intoxication is produced, with giddiness, faintness, noises in the ears, delirium, convulsions, disturbances of vision, prostration. The pulse is quick and feeble, and the breathing difficult; and there may be pain and difficulty in making water. A piece the size of a nut has killed a child; but recovery has taken place from even nearly ½ ounce.

Treatment.—(1) Use the stomach-pump or an emetic.

(2) Give stimulants freely, preferably by injection into the bowel, as spirits given by the mouth would dissolve solid camphor in the stomach.

(3) Dash hot and cold water alternately over the head and chest.

(4) Keep the patient warm.

Cantharides (Spanish-fly) cause great irritation of mouth, throat, stomach, and bowels. There is vomiting and purging, blood being vomited and passed. The urine is bloody; there is strangury, fever, swelling of the salivary glands, loss of sensibility, and convulsions. Death has taken place from 24 grains, but recovery after an ounce.

Treatment.—(1) Empty the stomach by a pump, or give an emetic.

(2) Follow with soothing drinks, gummy or barley water, white of egg in water, iced milk, &c.

(3) Apply hot poultices to the belly, and give 30 drops of laudanum to relieve pain.

Cocculus Indicus is the berry of *Anamirta Cocculus*, a climbing East Indian shrub. The seed, which contains the poisonous ingredient, an active principle called **picrotoxine**, is inclosed in a dark brown husk, which contains no poison. If the whole berry is swallowed, less risk of poisoning occurs from the hard husk preventing digestion of the kernel. The seeds are fraudulently added to beer to increase its intoxicating property, and the powder is used in medicine as an ointment for vermin and skin diseases.

Symptoms are sickness, vomiting, muscular weakness, intoxication and stupor, sometimes convulsions.

Treatment.—(1) Use stomach-pump or an emetic.

(2) Give charcoal in water and again excite vomiting.

(3) Give 20 grains chloral hydrate in water, to be followed if necessary in fifteen minutes by a second dose of 10 grains. Bromide of potassium in 60-grain doses may also be given.

Digitalis Poisoning is not common, though accidents arise from the use of the medicinal preparations. The symptoms are sickness with vomiting of greenish material, purging with pain in the abdomen, small irregular slow pulse, and faintness if the patient attempts to sit up. The symptoms increase in severity with larger doses, pupils being dilated and fixed, the skin pale and covered with a cold sweat, urine is suppressed, and stupor precedes death.

Treatment.—(1) Use stomach-pump or emetic of mustard, zinc sulphate, or ipecacuanha.

(2) Give as an antidote 6 drops of tincture of aconite, and repeat it in half an hour if the heart's action has improved.

(3) Give stimulants freely, whisky, brandy, aromatic spirit of ammonia, ether, hot coffee, and if they are not retained on the stomach inject them into the bowel.

(4) The person must maintain the lying position for some time after the danger is over. Any attempt to sit up would be attended by danger of fainting.

Hellebore.—There are two varieties of hellebore, the **White** or *Veratrum album*, and the **Green** or *Veratrum viride*, or **American Hellebore**, called also **Swamp Hellebore** and **Indian Poke**. All contain an active principle—**veratria**—to which the poisonous action is due. From **Sabadilla** or **Cevadilla**, the dried fruit of a Mexican plant, *Asagræa officinalis*, this veratria is usually obtained.

The symptoms are those of irritation of the digestive canal, parched mouth, burning sensation in gullet, thirst, retching, vomiting, painful purging. There are also symptoms of nervous origin, headache, faintness, palpitation, a feeling of anxiety, pupils generally dilated, weak slow pulse, laboured breathing, and perhaps convulsions.

Treatment.—(1) Use stomach-pump or emetic.

(2) Give stimulants freely, alcoholic stimulants and hot strong coffee.

(3) Maintain the warmth of the person's body and keep him lying quite flat.

Hemlock Poisoning.—Several plants may be included in this paragraph. There is the Greater, Common or Spotted Hemlock, the Water Hemlock (*Cicuta virosa*), Fool's Parsley (*Æthusa Cynapium*, Plate XI.), Hemlock Water Dropwort (*Œnanthe crocata*). Their leaves have been eaten in mistake for parsley, and the roots of the last-named for parsnep. A whistle made of the twigs of the common hemlock has been the cause of death.

The symptoms begin with excessive weakness of the legs, which causes a staggering gait; and the weakness extends until it involves the whole body. There are sickness and a burning pain in mouth and throat. The upper eyelids lose their power and droop over the eyeballs, so that, on acount of the muscular weakness and this combined, the patient lies quiet with eyes closed. The pupils are fixed and dilated. The muscular weakness, going on to paralysis, gradually extends upwards till the heart and breathing become affected, and there is inability to swallow. Death arises from failure of breathing.

Treatment.—(1) Use the stomach-pump, or an emetic of 20 grains sulphate of zinc, or the same quantity of ipecacuanha powder.

(2) Give large quantities of strong tea or coffee, decoctions of oak bark, tannic or gallic acid in 10-grain doses, to precipitate the active principle of the drug in the stomach and prevent its absorption.

(3) Give stimulants of brandy, ether, ammonia; and keep the person warm by friction, hot blankets, &c.

(4) Artificial respiration should be resorted to to maintain the breathing, and 10 drops of tincture of belladonna may be given to stimulate the breathing.

Laburnum bark, leaves, pods, flowers, and seeds are all poisonous, owing to the presence of an active principle **cytisine**. Numerous cases of poisoning in children from eating the pods and seeds have occurred.

Symptoms are those of stomach and bowel irritation, accompanied by nervous symptoms. They are sickness, vomiting, and purging, pain in the belly, straining at stool, pallor and exhaustion, great restlessness, slow feeble pulse, drowsiness, insensibility, and muscular twitchings.

Treatment.—(1) Use stomach-pump, or mustard and water emetic, or ipecacuanha wine, an ounce in water.

(2) Give hot coffee and stimulants of whisky, brandy, or ammonia.

(3) Use a douche of hot and then cold water to the head and chest.

Lobelia Inflata (Indian Tobacco).—Many deaths are attributed to the administration of the leaves of this plant by so-called "medical herbalists." Sixty grains of the powdered leaves are likely to prove fatal. It acts as an irritant upon the stomach and bowels, producing sickness and vomiting, pain and purging, and great depression. Later, it produces nervous symptoms, muscular tremors, headache, giddiness, insensibility, and convulsions.

Treatment.—(1) If vomiting has occurred, an emetic may be unnecessary; if it has not occurred, give mustard and water, or zinc sulphate (20 grains), or ipecacuanha.

(2) Give strong tea, or tannic or gallic acid in a 30-grain dose in water.

(3) Stimulants are to be freely given, and warmth to be maintained, the person being kept lying.

(4) Give 20 drops tincture of nux-vomica as a nerve stimulant.

Meadow Saffron or **Colchicum** (Autumn Crocus) acts as an irritant to the intestinal canal, acting also upon the nervous system. Its irritant properties are displayed by irritation of the throat, thirst, burning pain in the stomach, persistent vomiting and purging. Accompanying these symptoms are intense prostration, weak fast pulse, much perspiration, and muscular twitchings. One ounce of colchicum wine has thus caused death.

Treatment.—(1) Stomach-pump or emetic.

(2) Strong tea, decoction of oak bark, or 20-grain doses of tannic or gallic acid.

(3) Free use of stimulants and drinks soothing to the irritated membrane of the stomach, white of egg drink, gum-water, barley-water, &c.

Nightshade, the **Woody Nightshade** (*Bitter Sweet*, or *Solanum Dulcamara*) with purple flowers and red berries, **Black** or **Garden Nightshade** (*Solanum Nigrum*) with white flowers and black berries, and the **Potato Apple** (*Solanum Tuberosum*), are sometimes partaken of by children because of the attractive appearance of the fruit, and cause poisoning. The symptoms are those of irritation of stomach and bowels described above, along with symptoms of nerve disturbance, stupor, convulsions, delirium, dilated, pupils. Treatment consists of an emetic as ordered for lobelia (see above), a purgative of castor-oil to expel any material in the bowel, and stimulants.

Privet Berries (*Ligustrum vulgare*) have also been responsible for deaths in children.

Symptoms and treatment are similar to that adopted in cases of poisoning from yew berries.

Pulsatilla (p. 893) and **Poke Berries** (*Phytolacca decandra*) belong to the same type of poisonous plants as privet berries, so far as symptoms and treatment are concerned.

Tobacco (*Nicotiana Tabacum*).—The poisonous active principle of tobacco is **nicotine**, which when pure is a very deadly poison. Cases of poisoning have occurred from using an infusion or decoction of tobacco for worms or to procure abortion. The symptoms are sickness, vomiting, great depression, and faintness, dimness of sight, weak pulse, cold clammy skin, convulsions and stupor.

Treatment.—(1) Use stomach-pump or emetic of large draughts of water, mustard (table-spoonful) in water, sulphate of zinc or ipecacuanha powder (20 grains) in water.

(2) Give strong tea, or 20 grains tannic or gallic acid.

(3) Use stimulants freely, brandy, aromatic spirit of ammonia, &c.

(4) Keep the patient warm, lying flat in bed.

(5) Give 20 drops tincture of nux-vomica in water.

Turpentine, taken by mistake or given for worms, may produce poisonous symptoms resembling those of opium, namely intoxication, then insensibility with contracted pupils, weak pulse, noisy breathing, stupor and convulsions. The treatment would be draughts of mustard and water to induce vomiting, milk, egg-water, barley-water, gummy water, and one ounce of Epsom salts in water to act as a purge.

Virginia Creeper (*American Ivy, Ampelopsis quinquefolia*).—The leaves of this plant, chewed by children, have occasioned poisoning with symptoms like those produced by yew berries. Treatment is the same.

Yew Berries and Leaves (*Taxus Baccata*) are also poisonous, and deaths of children have resulted from their being eaten. A tea of the leaves is sometimes used to restore monthly illness.

Symptoms are perhaps vomiting and purging, paleness of face, coldness of extremities, small pulse, dilated pupils, insensibility, and convulsions.

Treatment.—(1) Emetic of a table-spoonful of mustard and water, or 20 grains of either sulphate of zinc or ipecacuanha powder in water, to be followed by
(2) Stimulants of brandy, whisky, or aromatic spirit of ammonia.
(3) Maintain warmth by friction, hot bottles, &c.

Poisonous Clothing, Wall-papers, Hair Dyes and Cosmetics.

Poisonous Clothing is considered on p. 732.

Poisonous Wall-papers.—See Arsenic, pp. 823.

Poisonous Hair Dyes and Cosmetics.—Hair dyes and enamelling liquids for the skin frequently contain lead, and are apt to occasion symptoms of chronic lead poisoning (p. 1022). Lotions for the complexion are sometimes poisonous because of the presence of corrosive sublimate (p. 1023).

Poisonous Food.—See Unwholesome Food (p. 597), and see pp. 646, 653 for impurities in waters. Poisonous mushrooms are considered on p. 583.

SECTION VII.—AMBULANCE AND STRETCHER DRILL.

Ambulance:
- *Army Ambulance Work;*
- *Ambulance for First Aid in Civil Life.*

Stretchers and Stretcher Squad Drill:
- *Formation of Company for Stretcher Drill;*
- *Formation of Stretcher Squads;*
- *Exercising Squads with Stretchers;*
- *Equipment of a Stretcher Squad.*

Ambulance.

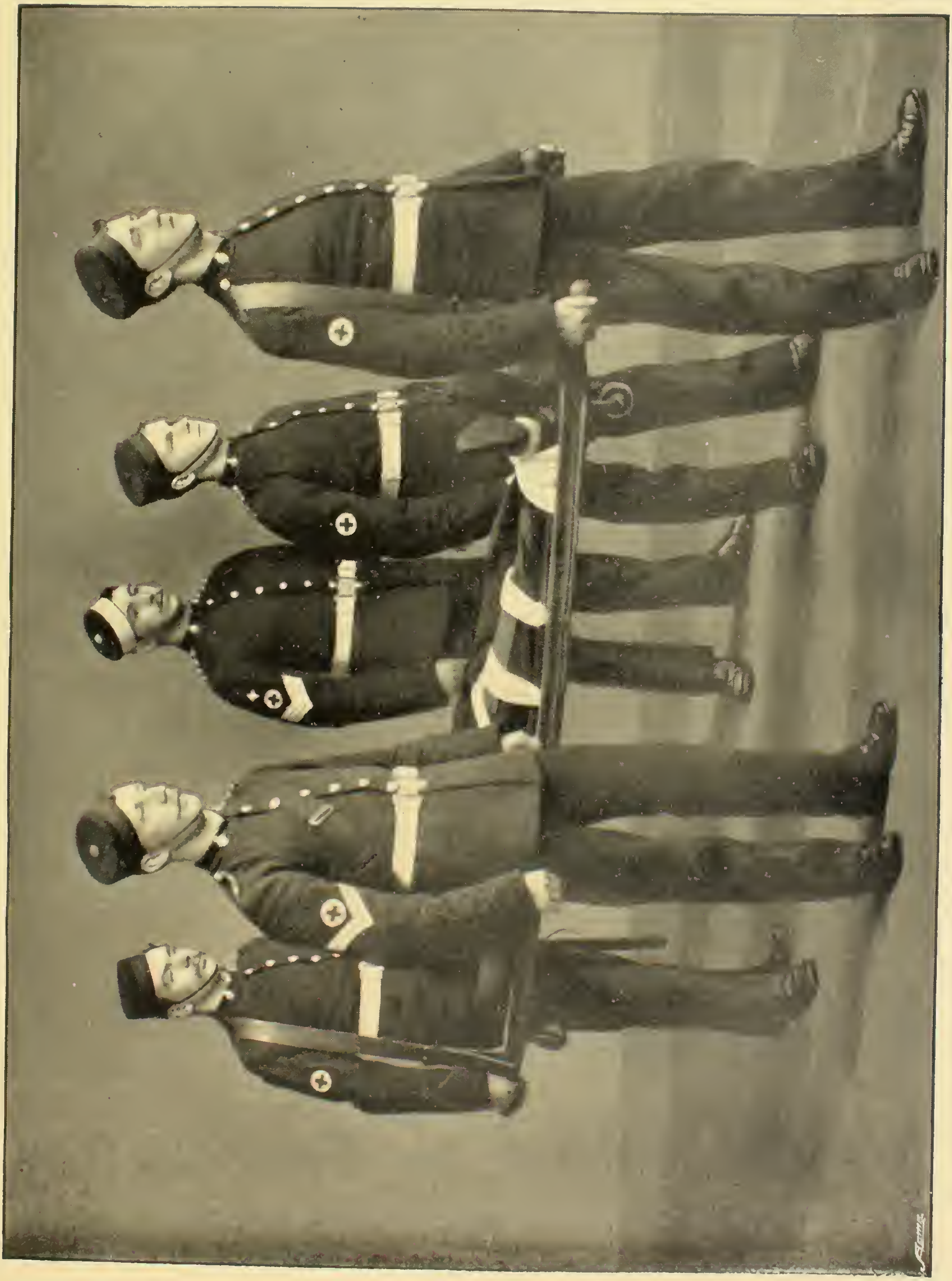
Army Ambulance Work.—In the English army ambulance system each division of an army corps has connected with it a Divisional Ambulance Company. This consists of two bearer companies, each of which is composed of 1 surgeon-major in command, 2 surgeon-captains or surgeon-lieutenants, 1 sergeant-major, 6 staff sergeants and sergeants, 6 corporals, 47 privates, and 1 bugler, as well as the officer and men of the Army Service Corps attached for transport duties. As every army corps numbers 3 divisions, each of which, as we have said, has 2 bearer companies, and as the army corps has besides a cavalry brigade, which has 1 bearer company (a half divisional ambulance company) attached to it, and a body called the Corps Troops, of reserve artillery and engineers, which has also 1 bearer company, each army corps has thus 8 bearer companies (or 4 divisional ambulance companies). The men of a bearer company belong to the Medical Staff Corps, and have no relation to the regiments, battalions, or brigades composing a division. They are an integral part of the Medical Department of the army, which is a completely separate organization. The bearer company is subject to its surgeon-major in command, and the two bearer companies of a division, forming the divisional ambulance company, are under the command of the principal medical officer of the division, while the four divisional ambulance companies of the army corps are medically administered by a surgeon-general on the staff of the general in command of the army corps. Each bearer company has a surgery wagon, fitted with baskets containing instruments and medical and surgical appliances, cooking utensils and medical comforts for the wounded, and carries an operating table, and surgical dressing tent, for fitting up at the dressing station; it has also

A STRETCHER SQUAD MARCHING WITH LOADED STRETCHER.

This shows a stretcher squad marching with a loaded stretcher, as described on p. 1041. The man carrying the foot end of the stretcher is No. 1 Bearer, the man at the head end is No. 3. No. 4 is on the right side, and No. 2 on the left. The extra man, with the three stripes on his arm, is the Sergeant in charge.

18a.

Plate XVIIIa.



A STRETCHER SQUAD MARCHING WITH LOADED STRETCHER

water carts and 10 ambulance transport wagons, as well as pack transport including cacolets and litters, field panniers borne by mules, &c. Further, each bearer company is disposed into 2 sections, each composed of 4 stretcher squads, each stretcher squad having a stretcher and 4 bearers, 2 to carry the stretcher, and 2 for relief, the latter two carrying surgical haversack and water-bottles. Thus in every bearer company there are 8 stretcher squads with 8 stretchers and 32 bearers under non-commissioned officers, the remaining members of the company being intended for duty at collecting and dressing stations.

When a division is on the eve of going into action, the 2 bearer companies of its divisional ambulance company form a dressing station, directly in the rear of the fighting line, but if possible out of fire. Here the operating tent is pitched and arrangements made for examining and classifying wounded and doing necessary operations and dressing, and administering food, &c., the officer-commanding and one other medical officer being in attendance. From the dressing station the ambulance transport wagons are sent forward to a position as near the fighting line as possible, where a collecting station is formed. Here the wagons are drawn up, and from this station the stretcher squads are sent forward, under one of the medical officers, on to the battle-field itself. A stretcher squad is ready to do any absolutely necessary dressing, to stop bleeding, &c., to give water or stimulant, and, as quickly as may be, places the wounded soldier on a stretcher, or otherwise assists him to the collecting station. At the collecting station the stretcher squads wait only long enough to transfer the wounded to the ambulance wagon, and return to the battle-field, never going in rear of the collecting station. The wagons then transport the wounded to the dressing station and again return to the collecting station. Such are the arrangements for giving immediate succour to the wounded.

Besides these arrangements there are others. Further in rear of the division, out of reach of the action, are the field-hospitals of the division, to which the wounded are taken from the dressing stations. Of these there are fourteen to each army corps, each fitted to receive 100 wounded. Here the slightly wounded may remain till they are able to go to the front and rejoin their regiment. These field hospitals move with the army, two or so miles in its rear, but still behind them, and planted in the line of communications between the army and its base are stationary hospitals, each capable of treating 200 wounded, while at the base itself there are general hospitals, capable of accommodating 500 each. Finally, between the base hospital and the permanent military hospitals at home are the hospital ships. All these arrangements, it will be noted, are under the control of the Medical Department of the army, the head of which is the Director-general of the Medical Staff; and, as already said, the members of the Medical Staff Corps have no connection with the regiments or brigades. But each regiment or battery or brigade has its medical officer, who goes with his regiment, and has a certain amount of drugs and dressing materials with him, sufficient to meet ordinary cases not requiring prolonged treatment. He has, to assist him, trained bearers, with stretchers and surgical haversacks, obtained from the regiment to the number of two soldiers per company. They form the Regimental Ambulance Bearers, have nothing to do with the organization of the Medical Staff Corps, and follow the regiment wherever it goes. In action they move about the battle-field, always in touch with their own corps or regiment, giving succour, and carrying wounded to the rear, where they hand them over to the men of the Medical Staff Corps.

In the volunteer army, until quite recently, there was almost no ambulance organization. Each regiment had one or more medical officers, but there was no bearer company, not even a stretcher squad. Recently this had been remedied to this extent, that most regiments have now an ambulance company of one or more stretcher squads with trained bearers. Behind the regiments, the deficiency was still greater. Now a Volunteer Medical Staff Corps is being raised in England and Scotland, but a regular organization of a bearer company under a principal medical officer for each regimental district is not yet within reach of realization.

Ambulance for First Aid in Civil Life.—In civil life accidents are frequent—on the street, on the railway, in the workshop, in the mine, at the dock; and much suffering and even loss of life are occasioned by the ignorance of those about the injured man, their inability to recognize what aid may be temporarily useful, and their awkwardness even in transporting him to some place where help may be obtained. In 1878 the St. John's Ambulance Association was founded in England to meet these conditions. Its objects were, by means of classes, open at little or no fee to the public, to teach the people how to render intelligently first aid to injured persons pending the arrival of skilled medical assistance, and to place stretchers, ambulance wagons, and other appliances in suitable places for the ready and safe transport of injured persons to hospital. In 1882 the St. Andrew's Ambulance Association was founded in Scotland with similar objects. The centre of the former association is in London, of the latter in Glasgow, but they have branches all over the kingdom, and everywhere local committees can be got up and arrangements made for lectures on "First Aid". As a result of the work of these organizations very many persons of both sexes have received a training in "First Aid", so that were a person seriously injured in a busy thoroughfare, it is almost certain someone would be found in the neighbourhood who knew at any rate how to prevent further injury being done by kindly but uninstructed Samaritans. Many of the police of the larger towns have passed through ambulance classes, and in large public works, collieries, and so on, workmen have been trained to form an ambulance corps, while similar bodies exist in connection with the leading railways, composed of railway servants. In many industrial centres wagons are now placed, so that seriously injured persons can be safely carried to hospital. In America, in New York, Boston, and Chicago, civil ambulance arrangements are very complete. In New York the municipal district hospitals have regular wagons and a staff of surgeons and attendants always ready. The hospitals are in telephonic communication with the police stations and the leading thoroughfares, and within a few minutes of an accident a completely equipped wagon with a trained attendant can be on the spot.

The St. John's Ambulance Association, it may be mentioned, was formed in connection with the Knights of the Order of St. John of Jerusalem, one of the knightly orders of crusader days, founded to relieve the sufferings of the pilgrims to the Holy Land and crusaders. Then the Red Cross Societies, which sprang from the conference at Geneva, on 9th February, 1863, called to consider the subject of the treatment of wounded in war, exist in every European country. They are civil societies which send help to the field of war wherever it be, and whose flag with the red cross is recognized as protecting from molestation by either army.

Stretchers are contrivances on which wounded and helpless persons can be transported easily and without risk of injury from one place to another. As they are now familiar not only to the members of an army ambulance corps, but also, through the agency of ambulance classes, to a steadily increasing number of civilians, it will be well to note their construction. One of the earlier forms of stretcher was that devised by Baron Percy for the French army. It consisted of two parts, interchangeable. Each bearer carried a part, and thus any two bearers could in two or three minutes put together a stretcher and carry a wounded man from the field. Each part consisted of a pole, 8 feet long. At one end was fitted a lance head, of such a shape and so fixed that it could be detached and sheathed in a scabbard at the bearer's side. When it was fixed on the pole it provided the bearer with a weapon of a lance description, and when detached it could still be employed for attack or defence. The other end of the pole was provided with a ferule. Another portion of each bearer's equipment was a piece of canvas of the proper length for the stretcher, but only half the breadth. Along one side was a broad hem, into which the pole could be passed, along the other side of the canvas was a row of eyelet holes. When each bearer had taken off the lance-shaped point of his pole, and passed the pole along the hem of his piece of canvas, he had half a stretcher, and these two halves were laced together by a cord fastened to the sacking. The stretcher was still, however, incomplete, for if it were laid down a person lying on it would have nothing but the sacking between him and the ground. Besides, the weight of a person's body would cause the two poles to come together, unless some rigid material extended between the two poles to keep them apart. Accordingly, each bearer carried over his knapsack a broad piece of wood long enough to extend from one pole to another. Near each end of this cross-piece was a round hole through which one of the poles was passed, and each end was prolonged downwards a sufficient length to act as a foot, so that when the stretcher had been fitted with one of these at each end, the two poles were kept fully apart, the canvas was kept stretched, and when the stretcher was laid down the feet kept the canvas off the ground, and the wounded man was thus protected from wet, damp, or cold ground. Under cover, in the absence of other appliance, the stretcher could act as a hospital bed.

The present regulation stretcher of the English army is known as "Surgeon-major Faris's Stretcher", and is thus described by Surgeon-major Evatt: "It is most solidly built, and consists of two side poles of ash, brown canvas bottom, a pillow, two self-locking traverses, which lock under the stretcher and keep it open. There are four wheels of lignum vitæ, on which the stretcher rolls into the ambulance wagon, and which act as legs when used as a camp bedstead, a use to which all army stretchers are liable. It weighs 32 pounds, and costs at the Royal Arsenal, Woolwich, about £3. To aid the bearers it has two leather slings, one at either end, which the bearers put over their neck like a milkman's yoke, and so relieve their arms of part of the weight." A strap fixed transversely near one end of each sling keeps both poles together when the stretcher is folded up.

Besides the poles on which the canvas is stretched, the requirements of a stretcher, which permit of many varieties of form, are the traverses, the cross-pieces, that is, which keep the poles apart when the stretchers are prepared for use, and the feet. In the English pattern the traverse is in two halves, one being fixed on each hole, and they are hinged at the centre, the end of one half overlapping that of the other half and hooking on to it when the traverse is straightened. The traverses are fixed near the ends of the stretcher, so that the bearer's hand passed under the end of the canvas readily grasps the traverse, and straightens it, thus separating the poles to the utmost, and fixing them. The feet also permit of many varieties of form, some as in the Faris pattern having small wheels in a fixed position, others having feet which fold up when the traverse is folded, and extended when the traverse is straightened. There is yet needed, however, a stretcher for both army work and for accidents in civil life, which besides being strong enough to fulfil all the requirements of carriage, will also be so light that one man can run with it, so arranged and made of such material that it can be folded up so as to occupy small space, so simple in construction that no mechanical knowledge is required to understand its parts, that it is not easily broken and not apt to get out of order.

Various modifications have recently been devised for use in mines and pits, where accidents are so numerous, which permit an injured man to be raised up the shaft in a comfortable position and secure from slipping.

Surgeon-major Evatt recommends, and ambulance associations all over the country are endeavouring slowly but steadily to realize it, "that stretchers should be kept in every street in our great cities, in a stretcher locker [painted red] of which the police and certain residents should have keys. Every railway-station should also have one, also every guard's van in all passenger trains. No public school, factory, institution, or asylum should be without such aid in carrying injured people. Probably many chemists would be glad to keep such stretchers in their pharmacies, and exhibit a notice to that effect in their windows, if any philanthropic society would provide the article."

Stretcher Drill.—Ambulance classes for giving to civilians training in rendering first aid to injured persons are now numerous all over the country. Part of the instruction they invariably receive is in the use of stretchers, and a modification of the stretcher drill as used in the army ambulance work is commonly employed. The writer's experience, however, is that a literal adhesion to the army drill is not attended by any difficulty, a company of boys even going through the movements with great precision and accuracy after two or three drills, and evincing real enjoyment in the occupation. The author, therefore, thinks it will be useful to ambulance societies and ambulance pupils to give that drill in detail.

The most suitable number to drill together is sixteen or twenty. That would be a sufficient number for four stretcher squads with four stretchers. Of course even only four would be sufficient to drill together as one squad, but it is well to drill two or three squads together in order to excite a healthy rivalry, and also to inculcate the necessity of all working together, not only the members of one squad working as one man, but all the squads keeping together as one man.

Formation of Company for Stretcher Drill.

The instructor takes up his position opposite the place where he wishes the right-hand man of the line to stand, and gives the command

Company—fall in.

Whereupon the men take places in succession, the man at the right-hand end of the line taking his position directly facing the instructor, and two paces in front of him, the remainder falling in one after the other in line with the first and on his left. Each man as he falls in takes up the position of attention, already fully described on p. 761, the elbows being slightly turned outwards. When all are properly in line each man should be able to feel his right or left hand man at the elbow, and to see the lower part only of the face of the second man from him on either side, by turning his eyes to one side or other, but his head being kept unmoved. The line is now to be "sized", that is to say, the men will be caused to change their position in the line, the tallest man being placed on the extreme right, and the shortest at the left end of the line, the remainder occupying a position in the line according to their size. This is done by the following orders:—

Number.

Upon this the right-hand man calls out "one", the second man "two", and so on down the line.

The instructor will then form the company two deep in the following manner. He will first give the order,

Odd numbers one pace forward, even numbers one pace step back—march.

Whereupon numbers 1, 3, 5, 7, &c., down the line step forward one pace, numbers 2, 4, 6, 8, &c., down the line step back one pace.

The instructor next cautions No. 1 to stand fast, and commands

Ranks, right and left—turn.

With the word "turn" the front rank (the odd numbers) turns to the right, except No. 1, who still keeps facing the front; the rear rank (the even numbers) turns to the left. In this position the front rank is facing to the right, and the rear to the left.

The next order is

Form company; quick—march.

At this command No. 3, the second man of the front rank, marches up and places himself behind No. 1, and two paces (60 inches) in rear. The next front-rank man, No. 5, marches up to the left side of No. 1, where he halts and turns to the front. The next front-rank man, that is No. 7, marches up behind No. 5, and is thus in line and on the left of No. 3. Meanwhile the remaining men of the front rank are marching up, and are taking their position alternately in the front and rear ranks, as already described for Nos. 3, 5, and 7, and the rear rank is marching down behind the front rank to tail in with and follow up the last man of the front rank, and to take position, one to the front and the next to the rear, as already noted.

In marching up, the front-rank men form first one to the front, the next to the rear; but the rear-rank men form up, the first to the rear, the next to the front.

When this movement is completed the company is standing, in the position of attention, in line, two deep, and the shortest men are in the centre, and the tallest on each side of them.

The instructor then gives the order

Right—dress.

The right-hand man of the front rank stands fast, and the others glance towards the right, without moving the head, and shuffle forwards or backwards till each man is so in line that he is able to distinguish just the lower part of the face of the second man beyond him.

It is to be noted that in stepping forward or back, the step is begun with the left foot, which is carried forward or back a distance of 30 inches, the man's body being kept all the time perfectly erect. When the left foot has touched the ground, the right is carried forward or backward to be in position of attention, heels together, toes pointing outwards, and the feet forming together an angle of 45 degrees.

Each set of two, a front-rank and a rear-rank man, forms a file, and 8 files will thus contain 16 men in two lines of eight men each.

In the event of the company consisting of an odd number, the position third from the left end of the rear rank is left blank.

The company is again numbered *in files* by the command

Company—number.

The man on the extreme right calls out "one", the man next to him (in the front rank) "two", and so on down the line, the rear-rank men not calling out at all, since the number of their corresponding front-rank men apply to them.

The company having been thus formed two deep and duly sized, each man must remember his relative position in the company, and when at the next exercise the company is ordered to fall in, each man must quickly and quietly take his post, noting that he is in the proper attitude of attention and accurately in line with his neighbour.

Formation of Stretcher Squads.

The company has been drawn up, standing in line, two deep, as already described, and the files have been numbered from the right down the line to the left, so that the first or right-hand file is No. 1, the second file (on the left of No. 1) is No. 2, and so on. This numbering must be noted in explanation of what is to follow, where we shall have to speak of the files with odd numbers as "odd files" or "right files", and the files with even numbers as even files or "left files".

The instructor gives the command

Form—fours.

On the word "fours", the left or even files, that is Nos. 2, 4, 6, 8, &c., will step back 30 inches to the rear with their left feet, and immediately thereafter 27 inches to the right with their right feet. The result of this is that, considering for the moment only files 1 and 2, these two files form together a squad four deep, in which the front man is the front-rank man of No. 1 file, the second man is the front-rank man of No. 2 file, the third man is the rear-rank man of No. 1 file, and the fourth man is the rear-rank man of No. 2 file, and the company of 8 files is now standing in 4 squads, each four deep, separated by intervals from one another.

Each squad of four deep is called a stretcher squad, and each member of a squad is called a bearer.

In the further drill of a stretcher squad, it is necessary to give each bearer a number for purposes of identification. The bearers in the front rank are called No. 1 bearers, those in the second rank No. 2 bearers, those in the third No. 4 bearers, those in the rear rank No. 3 bearers. This is intimated to the squads by the instructor in the following words:—

Front Rank. No. 1 Bearers—stand at ease.

At the word "ease" the front rank down the line of squads takes up the "stand at ease" position, described on p. 761. Then the instructor proceeds

Second Rank. No. 2 Bearers—stand at ease.

Again on the word "ease", the second rank takes up the proper position, so the instructor proceeds

Third Rank. No. 4 Bearers—stand at ease.

Fourth Rank. No. 3 Bearers—stand at ease.

All the bearers having thus been shown what their numbers are, the instructor brings the squads to their former position by the command

Company—attention.

He may repeat this till every one knows his number as a bearer, and at once responds to his own number.

The next thing is to number each of these squads in order from the right. The instructor orders

Number—the squads;

and the front-rank man of the right-hand squad calls out "one", the front-rank man of the next squad calls out "two", and so on.

Exercising Squads with Stretchers.

Previous to the drill being begun, the stretchers are laid in a heap on the ground. The No. 3 bearers should now be marched to the heap, each No. 3 taking a stretcher for his squad. This is done by the following commands:—

Nos. 3—right (or left) turn.

All the Nos. 3 turn as ordered, right or left being ordered according to the position of the heap of stretchers. The next order is

File on stretchers—quick march.

On the word "march", the Nos. 3 step off, one behind the other, keeping step, the leading man taking the nearest way to the stretchers. When the stretchers are reached, the leading man picks up one and places it, at the slope, on his right shoulder, rollers to the front. He then marches on to give room for the other bearers to come up, each in turn, and secure a stretcher. When he has marched on sufficiently far, the instructor should give the order

Mark time in front.

When the last bearer has secured his stretcher, the instructor should order

About turn—forward;

whereupon the bearers should turn about and march back, still in file, but the bearer who was last now leading, till the squads are reached, when the bearers should march in, each to his proper place. The instructor then gives the orders

Halt. Front.

The instructor now gives the order

Lower—stretchers,

when the Nos. 3 take the stretchers from the shoulder and lay them on the ground on the right of the squad, passing what, at the slope, was the lower end to the front, rollers to the right of the squad. The next command is

Stand to—stretchers;

whereupon No. 1 sees that his toes are in line with the front end of the poles, No. 3 that his heels are in line with the rear end, No. 2 that he is one pace in rear of No. 1, and No. 4 one pace in front of No. 3, all touching the stretcher with the right foot.

The squads are next to be exercised lifting, marching with, and lowering stretchers.

On the command

Lift—stretchers,

Nos. 1 and 3 (the front and rear men) stoop down and take hold of the handles of both poles with the right hand—rollers away from them—and rise to attention together, holding the stretcher at the full extent of the arms.

In stooping, the men must keep the knees straight; the rear bearer must time his movements with those of the front-rank man, and the men of succeeding squads must time their movements with those of No. 1 squad, so that all the squads act together as one man.

On the command

Lower—stretchers,

Nos. 1 and 3 stoop down, place the stretcher on the ground and rise to attention together, again all squads acting together, taking time from No. 1.

Marching with Stretchers.

The squads are now made to lift stretchers and practise marching in close order, the following being the commands:—

Lift—stretchers.

If several squads are drilling together, they are caused to dress up in line with one another and at proper distance from one another (27 inches) by the command

Right (or left)—dress.

The No. 1 of the flank squad named (right or left) stands fast, the Nos. 1 of the other squads look to that flank and move up or back to get into line, the other bearers look straight to their front and get accurately behind the bearers in front and at proper distance. The dressing being finished, the instructor gives the order

Eyes—front,

when all look straight to the front. This being done, the instructor calls out

The Company will advance. By the right (or left), quick—march;

whereupon the squads all start off with the left foot, keeping in line with the squad named, that on the right or left as the instructor happens to order.

When the company is on the march, at the command

The Company will retire. About—turn,

the bearers of each squad will turn about towards the stretcher, Nos. 1 and 3 transferring it from the right to the left hand at the same time. When retiring the company is made to advance by the command

The Company will advance. About—turn.

The bearers turn *towards* the stretchers as in retiring.

The squads should also be practised marching in extended order, with four paces interval between each squad. The squads having been made to lift stretchers, receive the order

From the right (left, or No. — squad), to four paces—extend.

The squad named (right, or left, or No. 2, &c.) stands fast, the other squads turn to right or left, away from the named squad, and step off in quick time.

Suppose the order has been "From the *right*, to four paces—extend", then the right-hand squad—that is No. 1 squad—stands fast, the other squads turn to the left and step off. As soon as the squad next to the right—that is No. 2 squad—has taken four paces, it halts and turns to the front. The No. 1 bearer at the moment of halting taps with his left hand the shoulder of No. 1 bearer of the next squad—No. 3 squad. That squad (No. 3) takes four paces from the moment their No. 1 bearer has been tapped, and it then halts and turns to the front, their No. 1 bearer, at the moment of halting, tapping with his left hand the shoulder of the bearer in front of him, that is No. 1 bearer of No. 4 squad. So the process would go on though twenty squads were drilling together, till the whole twenty were extended in a line at four paces interval from one another.

If the order has been to extend from the left, then the left-hand squad stands fast, and the others turn to the right and step off, the first squad from the left taking four paces, then halting and turning to the front, their No. 1 bearer tapping the No. 1 bearer in front of him at the moment of halting, and so on.

Suppose four squads drilling together, and the order to be "From No. 3 to four paces—extend", then No. 3 stands fast, the others turn away from No. 3 and step off. That is, Nos. 1 and 2 squads turn *to the right* and step off, No. 2 halting as soon as four paces have been taken, their No. 1 bearer tapping, as he halts, the No. 1 bearer of the squad in front—No. 1 squad, No. 1 continuing with other four paces before halting and turning to the front, while No. 4 squad turns to the left, steps off for four paces, and then halts and fronts.

If this movement of extension is ordered while the squads are on the march, the named squad (right or left, &c.) continues to move straight on, but with a short step (21 inches), the remaining squads make a half turn to right or left, keeping at the full pace, and, when they have reached the proper distance, turn to the front and step short. When all the squads have reached the proper interval, the full step is resumed on the command

Squads—forward.

If the squads have been extended, they may again be brought into close order. The command is

On the right (left, or No. — squad)—close.

If the squads be halted at the time, the named squad stands fast, the others turn and march towards it at quick time, halting and fronting when the proper position is reached—an interval of 27 inches between each squad.

If the squads be on the march, when the order is given, the named squad marches straight on, *stepping short*, the other squads make a *half turn* towards it and close in upon it at quick time, each squad turning to the front and stepping short, when its proper position is reached. When all the squads have closed in, the full step is resumed on the order

Squads—forward.

To Prepare Stretchers for Use.

The squads are brought into extended order (4 paces interval) as already explained. The command

Prepare—stretchers

is given. On the word "stretchers" Nos. 1 and 3 of each squad turn to the right, kneel down on the left knee, unbuckle the straps, separate the poles, pass a hand under the traverse to make sure that it is locked. The slings are then taken and doubled, dressed side of the leather out. The loop formed by the doubling is slipped on the near handle of the stretcher, and the free ends rest over the opposite handle. Both bearers then rise to the former position, Nos. 2 and 4 meanwhile standing fast. The rear bearer keeps time with the front bearer, and those of succeeding squads with No. 1 squad. The front bearer of No. 1 squad must, therefore, make certain the other bearers are ready before he rises, so that all may rise together.

On the order

Close—stretchers,

Nos. 1 and 3 turn to the right, kneel on the left knee, remove the slings from the handles and place them on the ground, place the hand under the canvas and bend inwards the traverse, raise the canvas, so that it does not catch between the poles, bring the handles together, rise, lifting the stretcher, face one another, place the handles between their thighs, rollers to the right of the company, roll the canvas tightly round the poles (towards the right of the company). Each takes a sling, passes the buckle end to the other, threads the transverse strap through the loop of the other sling and buckles tightly, close to the rackets. Grasping both handles in the right hand, back of the hand to the right, they turn to the right of the company in a slightly stooping position. From which, all being ready, they rise together and turn to the front, taking time from the right.

To repeat this exercise the company is ordered to lower stretchers, and the orders "Prepare stretchers", &c., are repeated.

Lifting and Lowering and Marching with Prepared Stretchers.

The next exercise is in lifting and lowering prepared stretchers, and in marching with them.

The order to prepare stretchers having been given and carried out as described, the command is given

Lift—stretchers.

On the word "stretchers" Nos. 1 and 3 stoop down, grasp the doubled sling, at the centre, with the finger and thumb of right hand, remove it from the handles and stand up. Each then takes a side pace to the right over the near handle, and closes heels. Each then places the sling, equally divided, over his shoulder, with the end to which the transverse strap is attached over the right shoulder. They stoop, slip the loops of the sling over the ends of the poles, commencing with the left, and then firmly grasp the poles. After a short pause they steadily raise the stretcher off the ground, and stand up, holding the stretcher at the full extent of the arms. No. 3 must keep time with No. 1, the stretcher being kept horizontal throughout. Thereafter No. 2 takes two paces to the front, and turns to the right about, thus facing No. 1; No. 4 turns to the left about (at the same instant No. 2 turns) and faces No. 3. Nos. 2 and 4 then adjust the sling on the neck and shoulders of Nos. 1 and 3 respectively, so that it lies accurately on the hollow of the shoulder in front and is well under the collar of the coat. No. 2 then takes two paces to the rear, and he and No. 4 front together. In all these movements the bearers must act together, turning together, &c., the time being given by the No. 1 squad.

In the early practice of this exercise, these movements are timed by the instructor calling out "one", when the bearers begin the movements. When they have completed them as far as placing the sling on the neck, he calls out, "two", when they stoop and adjust the slings on the poles; and "three", when they should rise together. But after some practice, the bearers must judge the times themselves.

On the order

Lower—stretchers,

Nos. 1 and 3 lower the stretcher to the ground, slip the loops off the handles, stand up, remove the sling from the shoulders, double and hold it in right hand between fingers and thumb, then resume the original position at the side of the stretcher by taking a pace to the left over the handle, stoop down, arrange the sling on the handles as already described, and rise together.

The stretchers having been prepared as described, and lifted, the squads are to be practised marching with them.

On the order

By the centre—advance,

Nos. 1 and 3 step off immediately, No. 1 with the left foot, No. 3 with the right, *so that the step is broken*, and no side-to-side movement communicated to the stretcher. Meanwhile No. 4 turns outwards (to the left), moves smartly round the rear bearer, and up to the centre of the opposite side of the stretcher, while No. 2 marks time one pace, and is thus opposite the centre of his side of the stretcher. Nos. 2 and 4 keep step with No. 1.

It is very important to see that the bearers so march with prepared stretchers that no jolting would be suffered by a wounded man borne by them on the stretcher. This is best secured by them taking a short step of 20 inches, the knees well bent, the feet being raised little off the ground, the step being broken, as already noted, and the stretcher being kept horizontal.

On the order

By the centre—retire

with prepared stretchers (or on the order "Advance", when the squad is retiring) the squad will wheel by the right to the rear (or front), No. 3 simply marking time, and slowly turning till the wheel is accomplished.

On the order "Halt" Nos. 2 and 4 resume their old positions, No. 2 taking one pace to the front, and No. 4 turning outwards and doubling round the head of the stretcher to his old place on the left of the stretcher.

To Load or Unload Stretchers.

To practise loading and unloading stretchers, men to represent wounded are caused to lie down, the head towards the company, ten paces in front of the company and extended four paces from one another. The squads, standing in close order with stretchers lifted but closed, receive the order

Take post at the right of wounded—advance.

Each squad moves to its patient and halts without further command two paces on the side indicated and in line with him. The following commands are then given:—

Lower—stretchers,
Prepare—stretchers,

and acted on as already described.

The next order is

For loading, lift—wounded.

Nos. 1, 2, and 3 wheel round by the patient's feet, and march up on his left side (No. 3 passing by the left of No. 4), No. 1 halting opposite his shoulders, No. 2 opposite the hips, and No. 3 opposite the knees. They turn towards him together, No. 4 then placing himself opposite No. 2, that is next the patient's hips. All kneel on the left knee. No. 1 passes his right arm beneath the patient's right shoulder and his left across the patient's body, his left hand being passed under the patient's right shoulder. Nos. 2, 4, and 3 pass their arms, close together, under the patient's loins, hips and knees respectively. If the patient is able, he places his arms round the neck of No. 1 bearer, clasping his hands. The bearers, as one man, slowly lift the patient 24 inches off the ground, resting him on their right knee. No. 4 relinquishes his hold, doubles round by the head of the stretcher to the centre of the opposite side, grasps the near pole with his left hand and the farther one by his right, lifts the stretcher and places it directly under the patient. He then kneels and helps to support the patient.

The instructor now gives the command

Lower—wounded.

The bearers gently lower the patient on to the stretcher, remove their hands from under him, special care being taken of any wounded part. They then stand up, and resume their former position in line on the left of the stretcher. To do this Nos. 1, 2, and 3 turn to the right, and wheel by the right to their places, No. 1 at and to the left of the patient's feet, No. 2 behind him, &c., No. 4 meanwhile turning to the left, and wheeling round the head of the stretcher by the left of No. 3 to his place behind No. 2.

The order is then given

Lift—stretchers,

and is carried out in the manner already described for unloaded stretchers. The squads are to be practised advancing and retiring with loaded stretchers, as they did with unloaded stretchers, the bearers marching with short broken steps to prevent jolting and injury to the patient, as already directed. This is made easier if the bearers are as nearly as possible of equal height. On sloping ground the general rule for bearers is to carry the foot end of the stretcher foremost down hill, and the head end foremost up hill. On halting and lowering stretchers, the bearers must take great care to prevent jolting.

The squads having been halted and the stretchers lowered, the command to unload the stretcher is given thus:

For unloading—lift wounded.

No. 4 turning outwards (to the left) doubles round the head of the stretcher to the centre of the opposite side, and the whole turn to the patient together, No. 1 placing himself opposite the knees, No. 2 opposite the hips, and No. 3 opposite the shoulders of the patient. They then proceed to lift the patient to their knees, as already directed. No. 4 grasps the stretcher, as before described, steps back two paces, places it on the ground, doubles back to his place round the head of the stretcher, and resumes the support of the patient.

The instructor then orders

Lower—wounded.

The patient is lowered, the bearers disengage and stand up, resuming their proper places at the left of the stretcher as follows:—All turn to the left, Nos. 1, 2, and 3 wheel by the left round the head of the patient to their places, No. 1 at the foot and to the left of the stretcher, &c., No. 4 falling in between Nos. 2 and 3.

The completion of the exercise is effected by the following commands:—

Close—stretchers.
On the right—close.
Lower—stretchers.
About—turn.

On the last order the bearers turn about, and on the further order

By the right—quick march,

they march off, leaving the stretchers on the ground.

When they have marched clear of the stretchers, they are ordered to halt, and immediately after the order is given

Front.

Whereupon the bearers, at the moment standing four deep facing the rear, turn together to the front and immediately form up two deep, by the Nos. 2 and 3 of each squad taking a pace of 27 inches to the left with the left foot, and a pace of 30 inches to the front with the right foot. This brings them into the formation described on p. 1036, before the formation of fours.

The next commands are

Right—dress (see p. 1036); **Right—turn,**

when the men will turn as directed. Finally on the order

Dis—miss,

the front rank will take a side pace to the left, and the rear rank will take a side pace to the right. After a pause the company will break off quietly.

Equipment of a Stretcher Squad.

Besides a stretcher, each squad should be provided with a water-bottle, and a haversack containing splints, bandages, a tourniquet, scissors, and safety-pins.

No. 2 bearer carries the water-bottle; No. 4 carries the haversack. The water-bottle hangs on the left hip, sling over the right shoulder, the haversack hangs on the opposite side.

A CHAPTER ON SICK-NURSING. MEDICAL AND SURGICAL APPLIANCES.

The Duties of a Sick-Nurse.
The Qualifications of a Sick-Nurse:
 The Dress of the Nurse.
The Sick-Room:
 Its Cleanliness; Its Ventilation; Its Warmth.
The Sick-Bed:
 Changing Sheets, &c.
The Sick Person:
 The Diet—Its Frequency, Quantity, and Method of Administration;
 The Administration of Medicines;
 Clothing—Changing Clothing;
 Discharges—Bed-pans;
 Bed-sores.
Medical and Surgical Appliances:
 Syringes, Inhalers, Nasal Douche, Catheter.
 Fomentations and Poultices.
 Leeches and their Application.
A Few Recipes for Sick-room Cookery.

The Duties of a Sick-Nurse.—It is an old notion that any woman who has reached, or perhaps still better, has passed, the prime of life, who has borne a large family, whether she has reared them well or not does not matter, who "has seen a lot of trouble," who has witnessed numerous death-beds, is very well qualified to be a nurse. She is "a woman of experience," and this kind of experience enables her, it is supposed, to act with authority and judgment in the sick-room, whatever be the nature of the disease the patient is suffering from, and whatever may be the emergency that arises. There never was a greater mistake than this; there is none more productive of evil to the patient. It is the same mistake which causes people to speak of the duties of the nurse, in contradistinction to the duties of the doctor! In the care and treatment of the sick the view, on which this mistake is based, supposes that the doctor has one well-defined limit of duty, and the nurse another, and the doctor must not trench on the nurse's province, lest he offend her. A nurse who takes up such a view makes a fatal mistake. She must begin her work with the idea firmly implanted in her mind that she is only the instrument by whom the doctor gets his instructions carried out; she occupies no independent position in the treatment of the sick person.

It is the doctor's business, and his only, having carefully inquired about all the facts relating to his patient's case, having thoroughly examined his condition, observed and considered all the symptoms, and having come to a conclusion as to the nature, and, if possible, cause of his illness, it is the doctor's business then to determine not only what medicines, if any, he will order for the sick person, but also what are the conditions under which the patient ought to be placed to enable him to wrestle with the disease under the circumstances most favourable for his recovery. He is bound to consider, that is to say, not only what medicines he will order, but also what food and drink are most appropriate for his situation, what kind of atmosphere he ought to breathe, what degree of heat that atmosphere should have, and every other circumstance that will aid his natural tendency to recovery. It is his business also to consider whether the surroundings of the patient are the best possible to conduce to this end, and if not, how they may be improved, so far as improvement is within the patient's power. Having arrived at his conclusions, it is then his duty to give his instructions to the nurse, to prescribe the medicines, to indicate the nature, amount, and frequence of the diet, how the patient is to be placed and covered in bed, to indicate how the apartment is to be kept as regards air and heat and light, and so on. It is the nurse's business carefully and accurately to note these instructions, not in a mere general way, but in every minute detail, to make certain that she understands the instructions given, and having received them, strictly but intelligently to act upon them and carry them out to the letter.

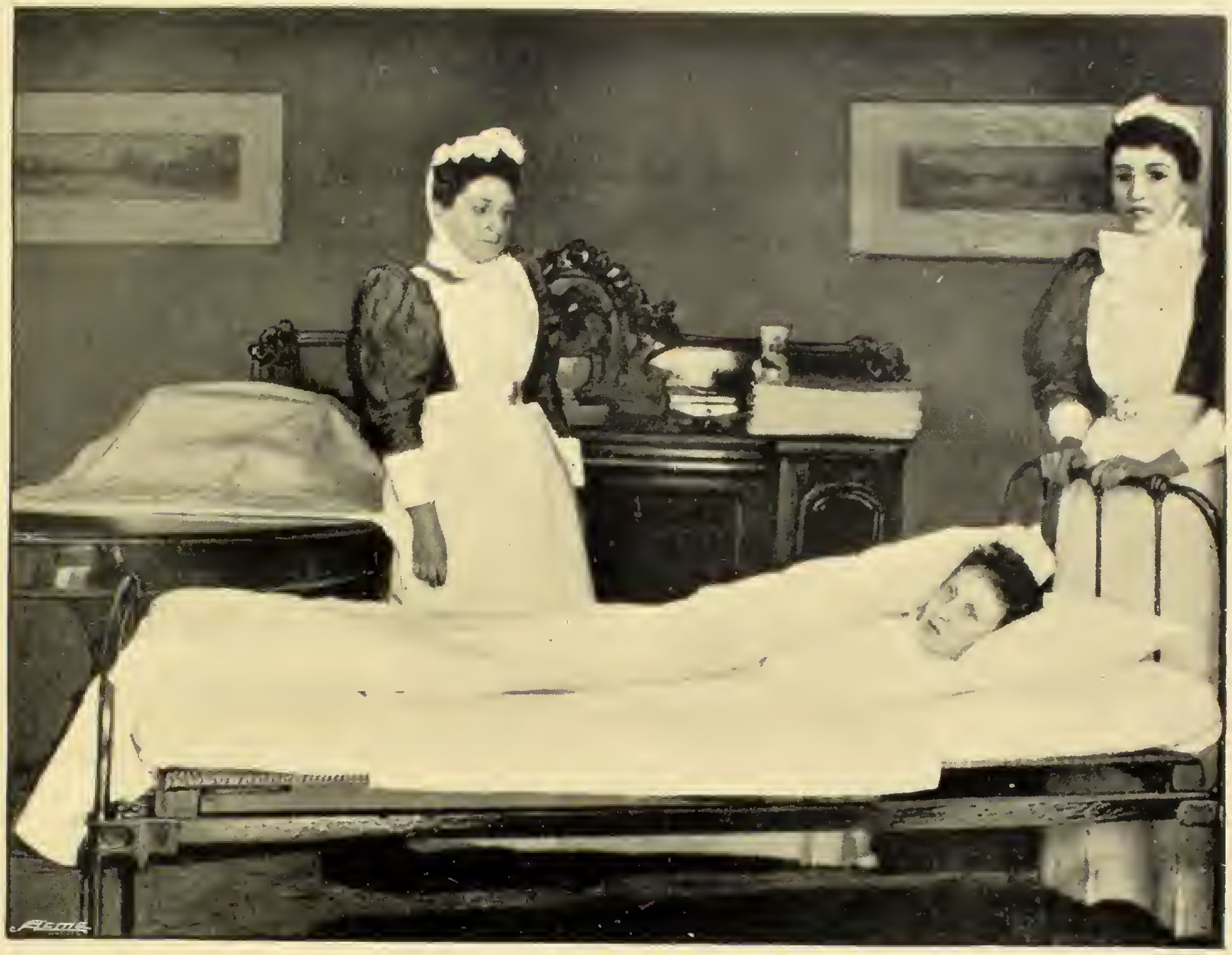
This is very different from the old notion that it was the doctor's business to come in, examine the patient, write a prescription, and walk off, leaving everything else to the nurse, as her business.

The first thing that is implied in this explan-

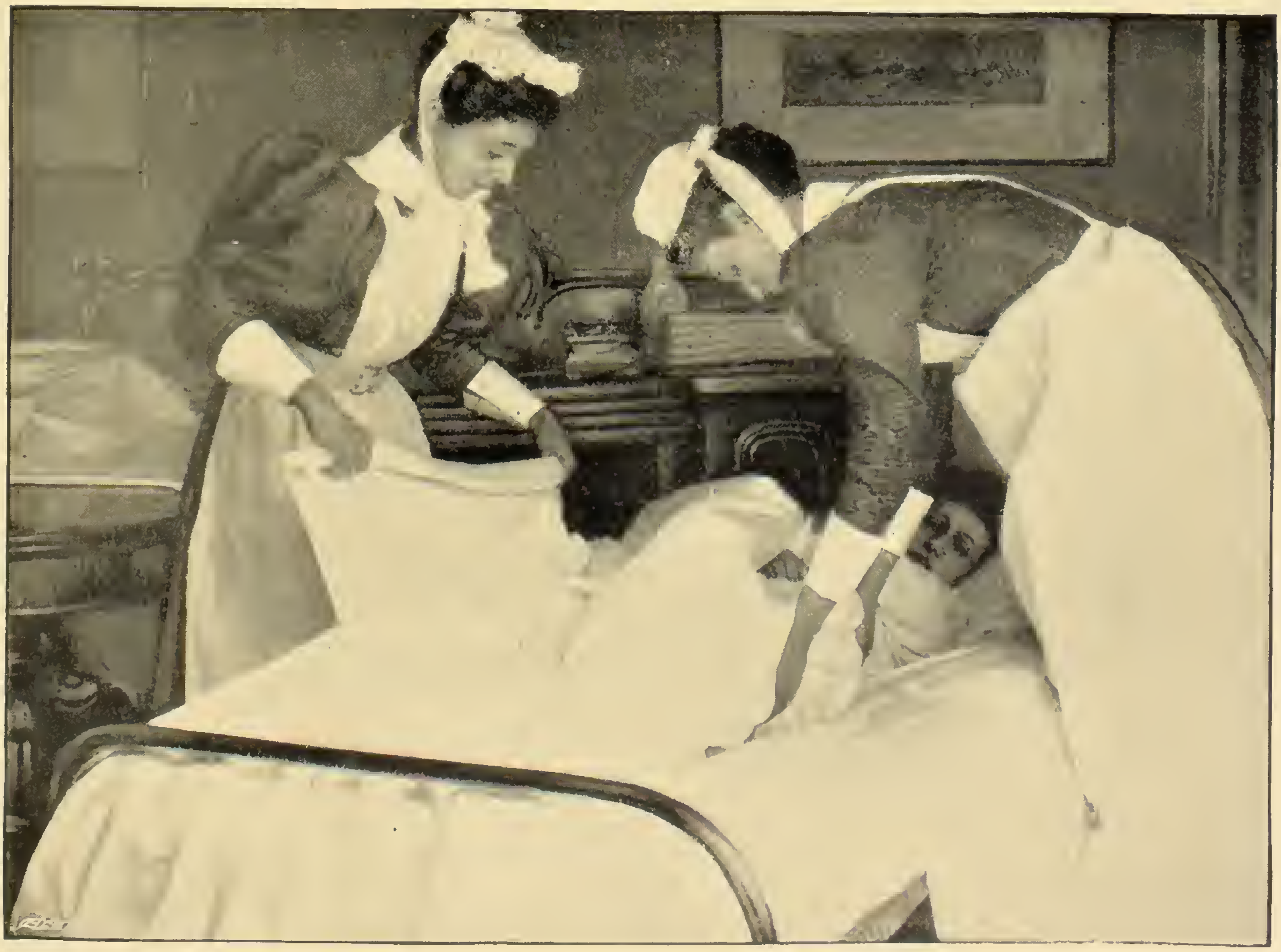
THE ARRANGEMENT OF THE SICK-BED.

I. The bed is made in the ordinary way. Across the centre of the bed, thus made, is laid a waterproof sheet, and above that is laid the draw-sheet, an ordinary sheet folded once. One end of this draw-sheet is pinned down as shown in the illustration, and this leaves a long end at the other side of the bed, which is folded up to obviate soiling. When the part of the sheet under the patient has become soiled, a fresh piece can be substituted by drawing the sheet through from the short side.

II. To change the draw-sheet when the patient cannot be moved from bed, the pins fixing it are undone; to one side a fresh draw-sheet is pinned; and then one nurse, by slipping her hands under the patient's body, eases up the patient sufficiently to permit the nurse on the other side to draw through the soiled draw-sheet, which, of course, drags after it the fresh sheet attached to it.



I. The bed-clothes folded over to show the draw-sheet pinned down on the top of the ordinary sheet.



II. The draw-sheet being changed.

ation of a nurse's duties is that she, as a nurse, has no responsibility whatever beyond the responsibility of carrying out her instructions. In the treatment of a sick person there can be no divided responsibility; if there is, so much the worse for the patient. The whole and undivided responsibility of directing the treatment belongs to the doctor, the nurse is responsible only for executing the directions, not in any degree for their nature or their results. This ought to be considered by her as a great relief, a great guarantee of security, provided always, and only, that she conforms to her instructions. The second thing implied in this explanation of a nurse's duties is that she, as a nurse, has no "opinions," no "thoughts." It is not an uncommon thing for a patient, or a patient's friends to say, "What is your opinion, nurse?" If she is a well-trained nurse she will, in effect, reply, "I have no opinions on the subject;" and she cannot more thoroughly demonstrate her want of qualification and suitability for the work she has undertaken than by launching into a long account of her experience when attending Mr. So-and-so, or of what happened in an exactly similar case she had, &c. It is also not an uncommon thing for a doctor, asking an explanation of some order being left undone, to be told that it was just about to be done, when, on account of something else "nurse thought," &c. The nurse must have no opinions and no thoughts, we repeat. If it is impossible for her not to think, and impossible for her not to draw conclusions from her thoughts, she must, at any rate, keep them securely locked up in a remote corner of her mind, where they will not interfere with her execution of the orders she has received. The general in command of an army confronting the enemy moves his troops in accordance with a plan of action in his mind. He orders his officers to move their battalions in accordance with his plan, and the duty of his officers is to obey the orders they receive. If every or any captain thinks he is entitled to carry out the order he has received only so far as he deems fit, or to alter it to what he thinks better, the plan of action will be upset and the battle may be lost. So the doctor, in his fight with disease and death, marshals his forces of medicines, food, drink, and so on, in accordance with a plan in his own mind, and if the nurse whose duty it is to carry out his instructions, thinks she is entitled to modify them or set them aside, the odds against the patient are all the heavier.

A second part of a nurse's duty is to observe. In many cases of disease various changes occur within twenty-four hours, the knowledge of which would be of great value to the attending physician, and which it is impossible for him to acquire by the daily visit or by the morning and evening visit. For instance, at one period of the day there may be an undoubted rise in the heat of the body. This may recur at or about the same hour every day, but there may be no evidence of it whatever at the usual hour of the doctor's visit. It is quite clear that if this were noted by the nurse and reported to the doctor, it would be a fact of much value. Or there may be spasmodic attacks of discomfort, or pain, or breathlessness, and so on. All such circumstances it is the duty of the nurse to observe and report. But she must beware of reporting anything but the bare facts. She is apt to have her own explanation of the facts she has observed, and to colour her report in accordance with her own idea of their meaning. It is necessary, therefore, for her to train her powers of exact observation, and to exercise herself in the task of reporting exactly what occurs without alteration or addition.

What, then, are the chief points a nurse has to include in her report to the doctor at his visit? She will have to inform him (1) as to the food and drink the patient has taken, since his last visit. This she must be prepared to detail as to its actual amount, and times of administration, as well as its nature. Thus her answer should run something like this: "At mid-day yesterday he had a breakfast-cupful of beef-tea and a quarter of slice of toast. At 2 afternoon another breakfast-cupful of beef-tea and half a slice of toast; at 4 half a tumbler of milk; at 8 —," and so on. And then she should be ready to sum the whole up in some such way as this: "In all, since yesterday at 12, he has had 4 pints of milk, $\frac{3}{4}$ pint of beef-tea, 1 egg, 2 slices of bread, and 4 biscuits." The doctor would then, it is evident, have a clear idea as to whether sufficient nourishment were being given or not.

(2) The second part of the nurse's report should be as to her administration of medicine, the amount given, the hours at which it was given.

(3) The nurse should be ready to state *exactly*—in hours and minutes—what sleep the patient has had, and whether the sleep was quiet and sound, or light, or troubled and restless, and so on.

(4) The nurse ought to be ready to inform the doctor as to the emptying of the bladder

and bowels, how frequently and at what hours these acts were performed. She should have noted in relation to the urine, the quantity and colour, and in relation to the motions their size, colour, consistence, whether formed or semi-liquid, whether uniform in appearance or mottled with patches of white, &c.

(5) The nurse should have observed and noted any other circumstances that may have occurred, such as sweating, coughing, spit, vomiting, delirium or wandering, excessive thirst, headache, or any other pain complained of. As regards cough and spit, she should be ready to state the time of their occurrence and recurrence, and should have preserved in a covered mug some of the spit for the doctor's inspection. As regards the vomiting she ought to be able to state when it occurred, how it was related in point of time to the giving of food or medicine, what it was like, and should have preserved some, *but not in the sick room*, for the physician's inspection.

A nurse cannot be expected to carry all these things in her memory, and therefore they should be noted down in writing. All this will be best done by the nurse, before assuming duty, providing herself with a note-book, not a tiny penny diary, but a sensible note-book, say about 7 inches long by 4½ broad, by ½ thick. She should rule a straight line down the outer edge on one side, giving a space sufficiently broad for marking the time, and a second broader space on the inner side for "Remarks." One page may stand for a day of 24 hours, or if the case makes frequent notes necessary, one page may note the occurrences from say 9 A.M. to 9 P.M., and the following page from 9 P.M. to 9 A.M. Then down the page are entered the facts as to food, medicine, &c., the hour being stated in the narrow outer column. At the head of each page the date would be entered. The doctor would likely enough take advantage of such a note-book to record the results of his observation of temperature, pulse, and breathing. Thus in the note-book one would have almost a history of the case and always an accurate record of its progress. One page of such a note-book would have something like the following appearance:—

March 10th.		Remarks.
9 a.m.	Small dessert-plateful of porridge and a tumblerful of milk.	
10 ,,	One tea-spoonful of medicine given.	
10.30 ,,	Two wine-glassfuls of milk and soda.	
11 ,,		Patient asleep from now till 11.45.
12 noon.	Tea-cupful of beef-tea, ½ slice toast.	
12.15 p.m.	Temperature 103° Pulse.......... 118 Breathing ... 24	Dr. called. Medicine to be given every 2 hours till further orders.
12.30 ,,	One tea-spoonful of medicine.	
1 ,,		Water passed, about ½ pint—very high coloured.
2 ,,	Tea-cupful beef-tea, ½ slice toast.	
2.30 ,,	One tea-spoonful of medicine.	
3.45 ,,		Patient slept from 2.45 till now; quiet deep sleep.
4 ,,	Half a tumbler of milk and two wine-glassfuls soda-water.	
4.30 ,,	Tea-spoonful of medicine.	
6.30 ,,	Tea-spoonful of medicine.	Profuse sweating for ½ hour.
7 ,,	Tumbler boiling milk, one slice toast.	Clothes changed.
8 ,,		Bowels moved freely—natural.
8.30 ,,	Tea-spoonful medicine.	
9 ,,	Half tumbler of milk and soda.	

It may be, and very often is, necessary for the nurse to prepare as well as administer the food of the patient. At anyrate she should be ready for such a circumstance if it arises. Therefore she should be able to cook, to prepare little dishes plainly but palatably; and she should take pains to acquire a knowledge of a variety of ways of cooking the same thing, so that she may tempt a patient's appetite or excite it. The sick man's stomach rebels against a diet from day to day everlastingly the same. And besides ministering to the feeble appetite by a dainty morsel of one kind or another, the nurse may coax a patient to try what she has prepared, by the cleanness and neatness with which it is set before him.

The Qualifications of a Sick-Nurse.—If such as have been stated are the duties of a sick-nurse, it will not after all be an easy task to fulfil them thoroughly. The qualifications for the post will be manifest. Intelligent, pains-taking, careful, exact, methodical, all these are very necessary qualities in the nurse. She must be scrupulously clean and tidy in all her ways. If so the sick-room will be clean and orderly, so also will the sick-bed be. In her person she will also be clean and neat. One thing is very important. Her breath must not be foul-smelling; and to ensure this she will do well regularly to use tooth-powder and mouth-wash (see recipes No. 85 and 81). Besides all this many other qualities are needed, pleasant manners, deftness and gentleness of touch, patience, quietness of manner, &c. All her work must be done without fuss or noise, and without the manner that is perpetually drawing attention to all she is doing. One thing a nurse must not be—a gossiper or chatterer. She may beguile a little time talking if the patient desire it, but it must not be with tales of her experiences, and accounts of the sick-beds of others, their sufferings and doings. His own symptoms and ailments and prospects are not to be referred to at all. Any information he desires on these points must be supplied by the doctor.

The Nurse's Dress and Behaviour.—It has been already said that the nurse should herself be scrupulously clean and tidy. Her dress should be of soft material that will not rustle, of a quiet colour, not black. It should be of material that will wash. A white apron with bib, a pair of close-fitting linen cuffs, and a white cap are also usual and desirable. She should wear soft slippers that make no noise as she moves. She should go about the sick-room quietly but with a decided step, not shaking the floor with her movements, but equally not sneaking about on tiptoe. She should speak in her natural voice, but quietly. Whispering is not permitted in a sick-room. A whispered conversation carried on outside his half-open door is to a patient particularly exasperating. All her own dressing the nurse should do outside of the sick-room. Her meals also should all be taken outside in some other room. When she is occupied about the patient her hands should be warm but dry. A cold hand, or a moist clammy hand, is an abomination. She can warm her hands with hot water, thoroughly drying them thereafter. If she is sitting in the sick-room, she will occupy herself with some light work or otherwise. But she must take care not to be unconsciously an annoyance. Sick people are so irritable, that the smallest thing is sufficient to disturb them. The rustle of a newspaper, or turning over the leaves of a book, the monotonous click of knitting-needles, the swing of a rocking-chair, or creaking of a wicker chair, all these may be seriously disturbing.

The Sick-room.—The sick-room should be, if possible, large, especially ought it to be so if the case is likely to be a prolonged one. It is a practical impossibility to ventilate without draughts a small room, and nothing is of greater consequence in the proper tending of the sick than the maintenance of a *constantly* pure atmosphere. All excess of furniture should be removed, as it simply takes up air-space. While it is well for the pleasure of the patient to have the room as bright and tidy as possible, it is undesirable to have much of the nature of ornaments and hangings, since they harbour dust. The wash-stand should be kept constantly clean and free from accumulations of glasses, cups, bottles, and all the odd etcetera of a sick-room with which it is usually littered. A small table should stand by the bedside, within easy reach of the patient's hand. The most it should ever hold should be a glass with a few flowers, perfectly fresh, a tumbler with drinking water, perfectly clean, and very frequently renewed, and, it may be, a small tumbler containing milk and soda or milk and ice. If ice is allowed the patient, the glass of drinking water may be replaced by a tumbler, covered with a piece of new well-washed flannel containing small pieces of ice, as shown on Plate XIX., fig. 7. If any orange or other fruit is allowed, a few small portions ought to be prepared, set on a plate which is supported on a bowl containing some pieces of ice to keep it cool. No food should be prepared or cooking done in the sick-room. All ought to be prepared outside, brought in when required, and the remains with the soiled dishes ought to be removed again from the room as soon as the patient has been satisfied. In the same way all soiled linen, towels, handkerchiefs, &c., should be removed from the room without delay and should be at once immersed in water.

No slop water should be retained in the room, nor slop-pail; all should be immediately removed, the vessels washed outside and brought back clean. It is never desirable that a sick-room should contain a set-in basin, connected with the drainage pipes. If such exists in the room, and another room is not to be had, strict orders must be given to prevent its being used. The waste-plug should be set in and the basin kept full of water, frequently run off and renewed. Basins which have no drain connection, but are provided with a tank underneath, are, in some respects, still worse. They invariably give out a very unpleasant smell. If the whole stand cannot easily be removed, the tank ought to be, and some deodorizer (p. 395) used for the stand.

The Ventilation of the Sick-room is more important than almost anything else. It is quite customary for ventilation to be effected once or twice a day by covering the patient wholly up, the head being covered as well, and then opening the windows for a few minutes till the air of the room has been completely renewed. This is all very well occasionally, but it cannot take the place of a constant renewal, which is necessary if the patient is to breathe a comparatively pure air. It is an absolute necessity that, since the air is being polluted every instant, fresh air should every instant be entering. This is ensured if a fire be burning in the grate. Therefore, one of the first things to be done in preparing a sick-room is to remove any ornaments in the grate, to open the damper, and to light a fire: if it be warm weather, the fire will of course be a small one. This fire will cause a constant current up the chimney and a constant stream through the room. The question is, whence is the air to come to supply this current? If the door and windows are kept close, it will create currents through every crack and crevice in door and window, and much of the common air from the house will be drawn through the room. If a way be opened for fresh air, however, it will be drawn less readily from other quarters. It will almost invariably be found best to draw down the window farthest from the bed, from the top, about ½, or even only ¼ of an inch, or 1 inch by day and ¼ inch by night. The bed can usually be so placed that it will not be struck by any current of cold air, and the atmosphere of the room will be kept pure. A screen can, if necessary, always be arranged to ward off any such current from the bed. Instead of this the fitting in of a board to close the opening left by raising the lower sash for a few inches, as mentioned on p. 694, may be employed. If the need of continually renewing the fresh air of a room be kept in mind there will be little need of burning pastilles or sprinkling perfume, *which, it must not be forgotten, may hide a bad smell but will never purify the atmosphere.*

The Warmth of the Sick-room should be maintained regularly at the same degree. This degree ought to be accurately estimated by a thermometer, kept hanging so as to be out of reach of direct heat from the sun or from the fire. Avoid hanging it on a wall kept warm by a fireplace in it. It may be a blank wall on the sick-room side, but a fireplace may exist on the other side. The usual height at which the mercury should stand is 65°—never above 70° nor below 60°. The nurse should, however, ask the instruction of the doctor as to the exact degree. A nurse must remember that if she is ordered to keep the room warmer that does not imply that she is at once to block up all means of entrance to fresh air. It may mean the use of larger fires, but while she seeks to get a warmer atmosphere, she must take care it does not at the same time become a more impure atmosphere. Nor yet must she think that if the atmosphere of a room is cold it is necessarily also pure.

Sunlight in a sick-room is always desirable, unless special circumstances require darkness. But the common supposition that a sick-room should be a darkened room is a mistake. Sunlight is one of the best of disinfectants. Let the bed, however, be so arranged that the light does not fall directly on the patient's face, either by the use of a screen or by turning the bed.

The Cleaning of the Room should be done systematically, all the more regularly in that while the patient is in it it can never be done thoroughly. It must be done so that the patient is not disturbed, and so that dust is not raised. Screen the bed if possible while it is being done; dust the furniture with a cloth slightly damp; carry rugs outside and hang them up in the outer air for a little; remove as much as possible from the carpet by using a large cloth rung tightly out of water. This is to be passed over the whole carpet, the part under the bed included.

The Sick-bed.—There are two things to be noted in considering the position of the bed. The first is its position in reference to any possible draughts from doors or windows. Given a room with one door, one window, and a fire burning in the grate, it is quite clear that a current of cold air will set in from the window to the grate, and one also from the door to the grate. It is wonderful how often the bed is so placed as to be simply swept across by one or other of these currents. Commonly this can be avoided. At the worst a screen can be arranged to guard the bed on one side. Let the screen be a high one. It may be improvised of a clothes-horse and sheets or blankets. In such a case let the sheets reach quite down to and rest on the ground. Another point to observe is that one fold of the screen ought to pass right in behind the head of the bed. Usually the screen is simply stretched out along one side of the bed, and there is a space between the end of the screen and the head of the bed. The cold-air current will simply pour through this gap on to the upper part of the patient's body. The second thing to be noted in the determina-

CHANGING THE UNDER SHEET IN THE CASE OF A HELPLESS PATIENT.

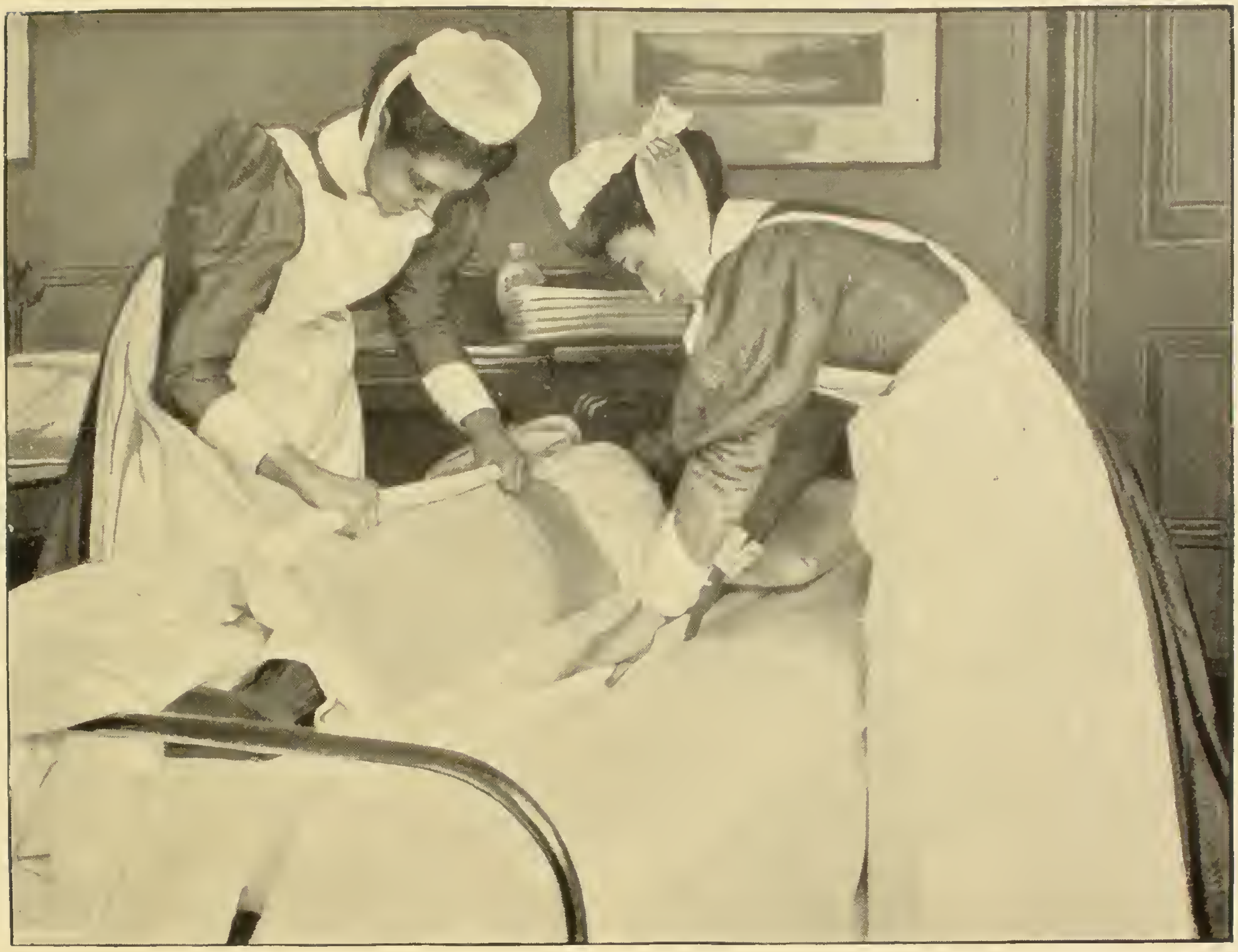
I. The patient has been turned over on the right side, the draw-sheet has been lifted on one side, and, with the waterproof under it, is being held up over the patient. At the same time it holds and protects the patient. The soiled sheet is then rolled up lengthways as far under the patient's body as possible. A fresh sheet, previously aired and warmed and rolled up lengthways to the extent of one-half, is now laid down and properly adjusted on the part of the bed from which the soiled sheet has been removed, the rolled part of both soiled and clean sheets lying alongside one another. The waterproof and draw-sheet are now pinned down over them.

II. The patient is now turned over on the left side, the draw-sheet and waterproof lifted. The patient is thus caused to turn over the rolls. The soiled sheet is removed, the roll of the fresh one unrolled and properly smoothed out, and the waterproof and draw-sheet again pinned down. Thus a clean sheet has been substituted for a soiled one.

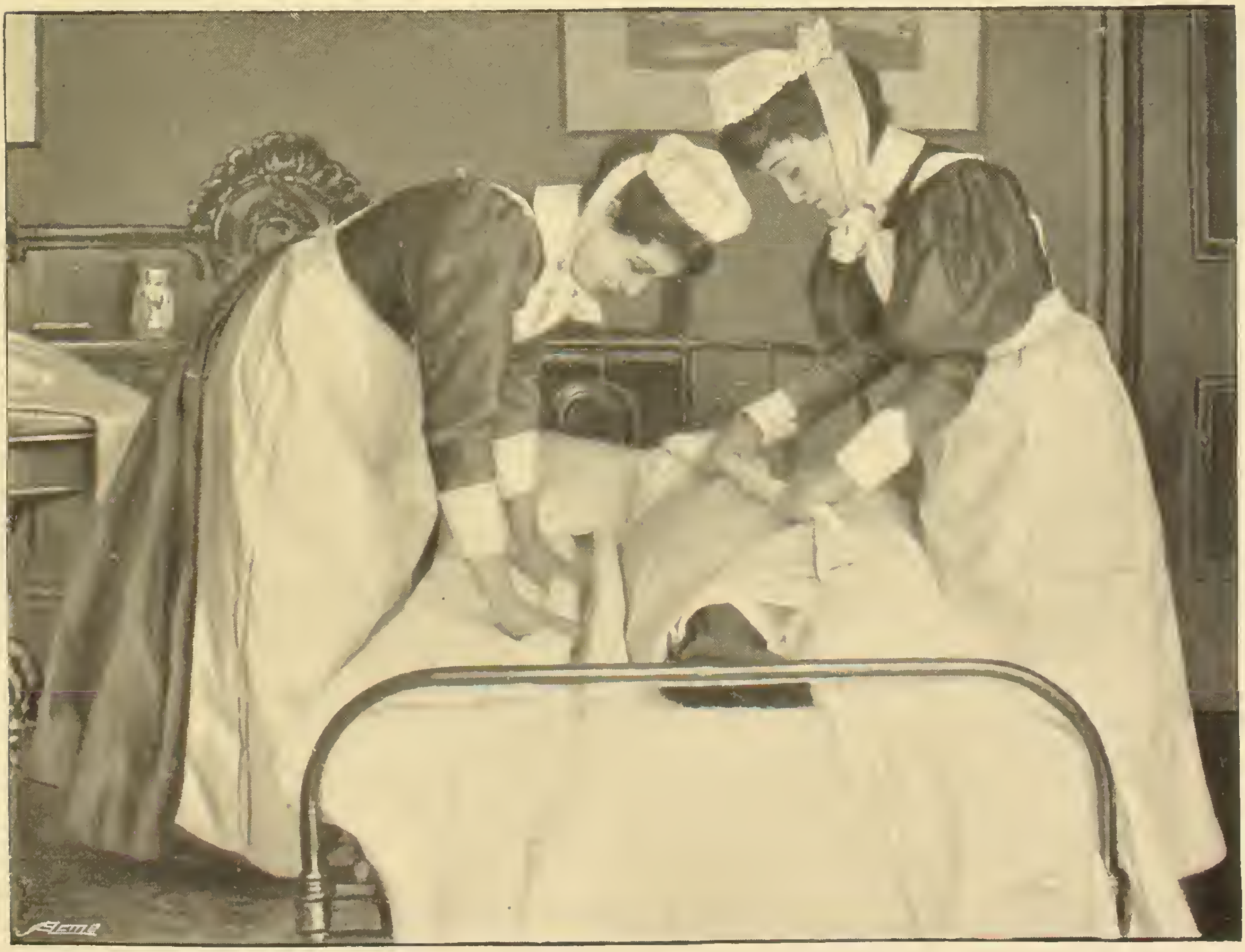
18c.

CHANGING THE UNDER SHEET IN THE CASE OF A HELPLESS PATIENT.

Plate XVIIIc.



I. The soiled sheet is rolled up lengthways close up to the patient, and the clean sheet, half of it also rolled up, placed alongside the soiled one.



II. The patient has been turned over on the other side, so that now the rolls of both soiled and clean sheets can be brought through from under.

tion of the position of the bed is the situation of the window. The patient should not be lying so as to face the window, if possible. It is always preferable that the bed should stand out a little way from the wall so that the nurse may easily get round it; and the fewer hangings there are about it the better. Valances prevent free circulation of air beneath the bed, and should be removed.

For any prolonged illness the bedding should be as follows: A hair mattress, protected on the top with a large square of india-rubber cloth. Above this is the under sheet. Then comes a folded sheet, spread across the bed so as to be under the patient. This is easily withdrawn when soiled without disturbing the under sheet and a clean one substituted. When there are discharges passed in bed the under sheet should be further protected by a layer of india-rubber cloth in the fold of the draw-sheet. Above the patient is a sheet, then the blankets, and then a covering of a clean sheet or other similar covering, but nothing heavy or cumbrous.

To Change the Sheets without Disturbing the Patient.—The upper sheet may be changed without folding down the clothes in the following way: The sheet having been warmed and aired (note: but not in the sick-room) roll it up in its breadth, then pass it across the bed at the foot under the sheet to be changed. Move it up over the patient, unrolling it as it goes till it is well up the bed. Then draw down the soiled sheet to the foot of the bed, and readjust the clothes. To renew the under sheet: Loose the soiled under sheet down the whole length of one side of the bed and fold it in a series of narrow plaits running lengthways close down by the patient's side. Take the fresh sheet, aired and warmed, and fold one-half of it in a series of plaits down its whole length. Lay the plaits of the clean sheet on the bed down the patient's side, alongside of the corresponding plaits of the soiled sheet. Push them up close to the patient, and gradually push them with the fingers under the patient's body, pressing down the mattress to allow them to pass. In this way the folds of the clean sheet are pushed under the patient and those of the soiled sheet *out from under* at the same time. Get the sheets pushed through under head, shoulders, and hips first, and then it is easy to raise the legs. Go round then to the other side of the bed, remove the soiled sheet, and spread out the clean one.

The pillows should be turned and smoothed frequently, and changed occasionally, and the patient should be helped to turn himself as a change. If he is sunk down in bed, the nurse assists him up on to the pillows again by bending over him, getting him to clasp his hands over her shoulders, while with her arms under his shoulders she assists him up the few inches that are necessary.

The Sick Person should wear an under-shirt of merino, and over that the usual night-gown. Only in the case of very delicate persons and children is a flannel gown necessary. It is always well to have two sets of clothing, one for night wear and one for day wear. The garments when taken off should be well aired in another room, and warmed when about to be put on again. The clothing may be regularly changed without raising the person in bed. The clothing to be put on, being well aired and warmed, is brought ready to hand. The person's arms are then slipped out of the sleeves of those he has on, which are removed by the feet while the fresh garments are put on over the head, and then the arms put in. If the case is likely to be a prolonged one it is well to have the clothing fastening down the front by tapes. The patient's hands and face should be sponged and the hair arranged now and again throughout the day; and the whole body may be sponged occasionally, as the doctor permits. This may be done under the bed-clothes just before removing the night garments. After the arms have been removed from the sleeves the nurse passes her hand under the clothes with a sponge well wrung out of soapy water, following with a towel. The whole body need not be done at a time, but bit by bit to avoid fatigue. It is well to guard the bed by a folded sheet with some rubber cloth in the sheet, pushed under the patient, while this is being done.

When it becomes necessary thoroughly to change the bed, and the patient cannot assist at all in the change, it is necessary either to move him to another bed pushed alongside the former one, and well aired and warmed for occupancy, or to place him for a time on a couch while his bed is being aired. To do this the assistance of three or four people is necessary. One stands at each corner of the under sheet, and the patient is lifted on this sheet, being kept covered all the time. He is then transferred to the fresh bed, and the fresh bed-clothes are rolled up in their breadth and introduced under the old ones in a roll at the feet, and gradually unrolled up over the patient. The soiled under sheet is then folded into plaits down the whole length on one side, and gradually pushed out beneath the patient's body and removed. If another bed is not to be had, the couch is prepared and the patient lifted to it on the under sheet. The bed-clothes, mattress, &c., are then removed to another room, and there well aired near an open window. Thereafter, after being well warmed, the mattress is restored, fresh bed-clothes having been meanwhile aired and warmed are placed on the bed, and the patient is replaced, the soiled under sheet being then removed from under him.

The diet of the sick person, as regards its nature, amount, and frequence of administration, will have been prescribed by the physician. It is well, however, always to remember that where there is any difficulty getting the patient to take much food at a time, or to take it at all, an ample supply may yet be given by the frequent administration of very small quantities. A patient who cannot be persuaded to take, say, a cupful of beef-tea, even at three hours' intervals, may yet be persuaded to take half a wineglassful every half-hour. In a very large number of cases, vomiting may be overcome by the frequent administration of very small quantities. It is very often quite useless to bring a patient any quantity of food; and any nurse who gave the doctor as a sufficient reason for the patient having taken no food, that she brought it to him but he would not take it, simply declares her own want of tact and patience and management. A nurse should never ask a patient "Will you take a little food now?" "What shall I bring you?" "If I bring you a small plate of soup will you take it?" and so on. She should study her patient; prepare quietly a small quantity of what seems proper under the circumstances; and then, bringing it to him, should be able with a little firm but gentle management to make him take it. Children are more difficult to manage, but if the nurse is of the right kind, and can exercise, without force or anger, a little gentle authority, the probability is that in a short time she will be able to get the little patient to take food in a perfectly satisfactory manner.

In Plate XIX., fig. 10, is shown a simple arrangement for enabling a sick person to drink from a tumbler placed on a table beside the bed without the tumbler being moved. The india-rubber tube should be considerably longer than is indicated in the figure.

As to the giving of medicines little need be said except in the way of urging exactness in following the doctor's directions, and in measuring out the quantity ordered. The quantity should always be measured in a graduated glass, such as shown in Plate XIX., fig. 8. The figures *c* and *d* are very useful for doses measured by drops. The india-rubber cap is compressed between finger and thumb, the end is inserted into the bottle, and by releasing the pressure the medicine is drawn up into the tube; by gentle pressure the medicine is then forced out drop by drop.

Discharges and Bed-pans.—Whenever there is any risk of discharges being passed in bed, a draw-sheet with an ample piece of india-rubber in the fold should be under the patient to protect the bed, and no soiled sheet should be allowed to remain in the bed. Plate XIX. shows two forms of urinals for use in the bed; and bed-pans are a necessity. They should be warmed before use by being dipped into warm water; they should then be well dried, and the edge protected by a towel. When it is introduced the patient's knees should be well bent. After use the bed-pan should be immediately removed from the room, and after being well washed should be deprived of all smell by being washed in the acid solution noted on p. 396.

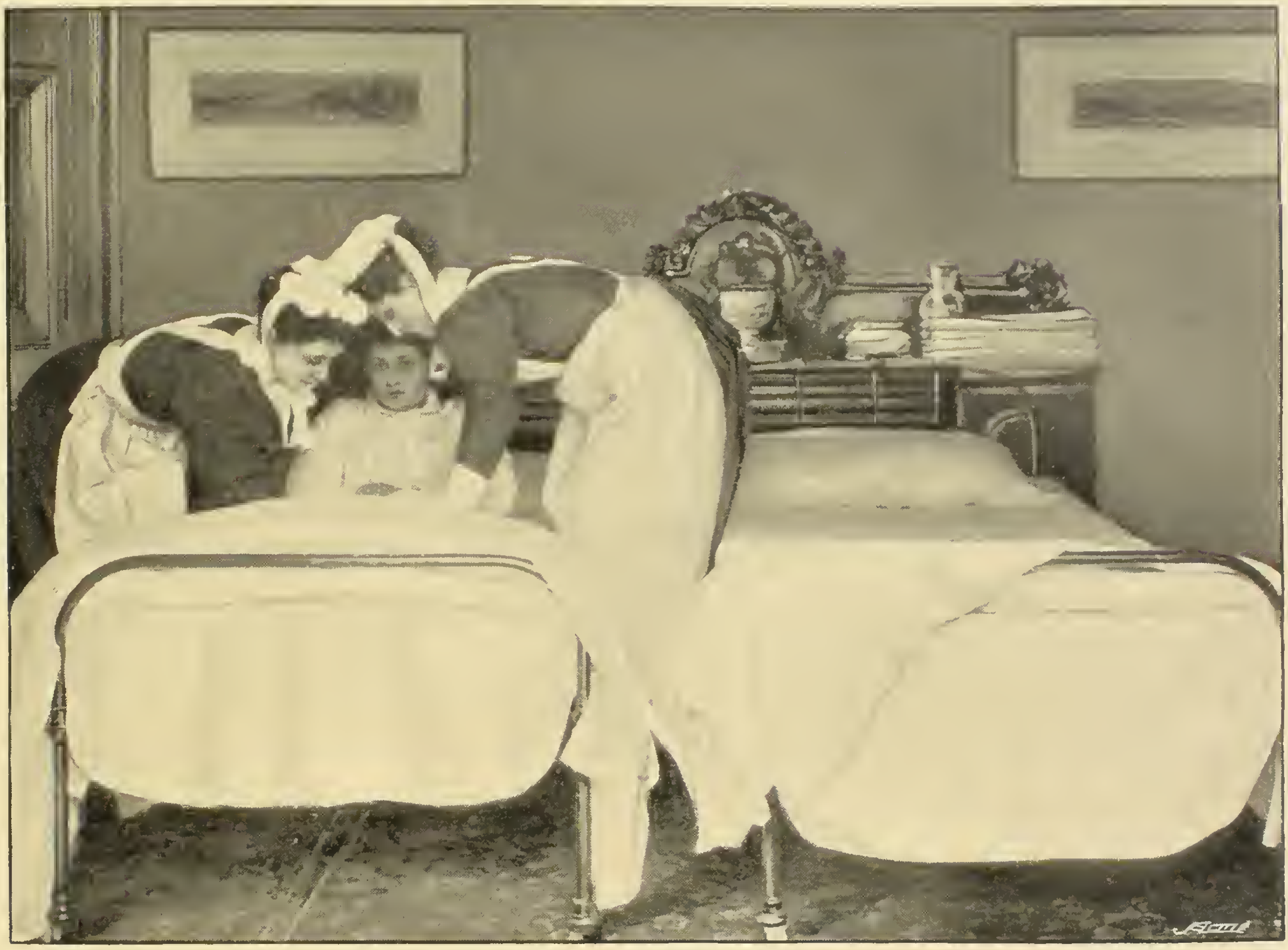
Bed-sores are the result of long-continued pressure on any part of the body, and they are specially apt to occur in persons of low vitality or in parts of the body where the nutritive processes are depressed owing to paralysis or other causes. Whenever long confinement to bed is necessary they must be carefully guarded against. In cases where, owing to the nature of the illness, the patient's susceptibilities are blunted, their occurrence must be anticipated, and regular examination of the body must be made to detect the slightest signs of their appearance. The places where they occur most frequently are those places which are subjected to the greatest degree of pressure—the heels, the lower part of the back, the prominence of the hip, the buttocks, and even the elbows. If the bed is not kept smooth, if folds are permitted to form under the patient, and specially if the skin is allowed to get soft and irritated by contact with wet clothing or discharges, a bed-sore is likely to be the result. With careless nursing great destruction of tissue may occur before the existence of the bed-sore is discovered. The part may be complained of by the patient as numb or tender or prickling, and the part looks red, or in more advanced stages livid or purple or black. A dark slough finally forms, and separates by ulceration, shreds and larger pieces being detached, till a large sore is

CHANGING BEDS IN THE CASE OF A HELPLESS PATIENT.

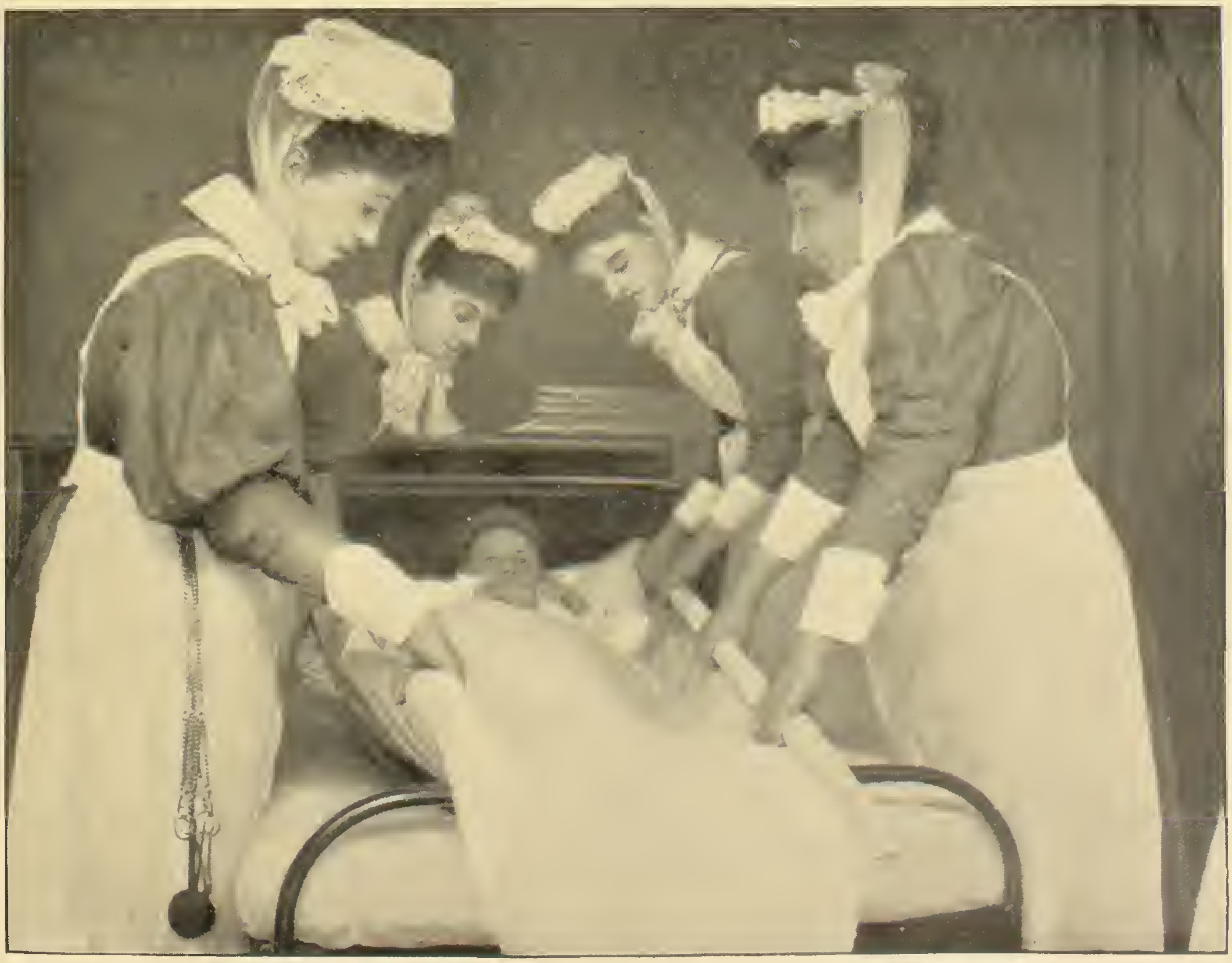
I. In this case the patient is able to sit up in bed. The clean bed is brought close up to the used one. The patient is lifted by two nurses, one at each side of the bed, who each pass the arm next the foot of the bed under the patient's thighs, and the other arm across the patient's back, locking the hands in each case. The patient is then lifted steadily and carried down the bed, over the lower end, and then backwards over the lower end of the clean bed and up into position.

II. This shows an easy method of carrying a helpless patient who must be kept in the horizontal position. Four attendants are required. Two poles six feet long are taken. The handle of a long broom will do, or a pole for raising or lowering windows. These are laid lengthways one on each side of the bed, and the under sheet rolled on them close up to the patient. The top sheet and one blanket are left on the patient, who is now carried, feet first, over the end of the used bed, and then, head first, over the lower end of the fresh bed.

CHANGING BEDS IN THE CASE OF A HELPLESS PATIENT.



I. When the patient is able to sit up in bed, she may be carried by two nurses.



II. A helpless patient, unable to sit up in bed, being carried by four nurses.

produced with ragged undermined edges, which may enlarge with great rapidity and pass deeply into the tissues.

To prevent the formation of bed-sores a feather-bed should be discarded, care must be given to keep the draw-sheet under the patient smooth, and to keep the patient constantly clean and dry. Then the parts on which pressure is exerted must receive special attention, and this long before any signs of the formation of a sore appear. They must be washed carefully with soap and water, and then thoroughly dried. Then there is to be gently rubbed into the skin pure spirit of wine, or eau de Cologne or whisky or brandy may be used. This is to be rubbed in till the skin is quite dry. The parts are then dusted with fine dusting powder; a quantity of powder is not to be put on, only enough to ensure the smoothness of the skin. The quantity should not be perceptible. Finally, pressure on the part is to be removed by the adjusting of air-cushions (Plate XIX., fig. 11), water-cushions, or pads of some kind. When a water-bed can be had it will greatly diminish the tendency to the formation of sores. The process of washing, bathing with spirit, &c., must be performed several times a day; and every part of the body carefully scrutinized at frequent intervals. If the surface appears abraded the same precautions must be carried out, and the air-pillows carefully adjusted. A lotion of 2 grains bichloride of mercury in 1 ounce of spirit is used to touch the surface. [*This is strongly poisonous.*] If a sore has actually formed, it requires the treatment of a bruised wound (p. 972). It is specially difficult to keep down fœtor; and for this purpose Condy's fluid in water, Sanitas, or some of the other antiseptics or disinfectants named on p. 910, must be freely used. The nurse must be careful that after such dressing of the wound no wet things are left about the bed, and that the clothes are made perfectly free from folds.

Medical and Surgical Appliances.

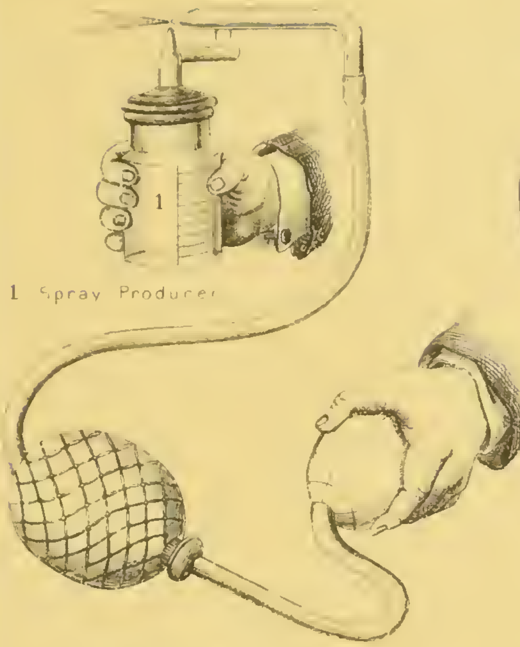
Plate XIX. contains illustrations of some of the more common appliances made use of in the sick-room. Several of these have been sufficiently referred to in the previous paragraphs. Figs. 1, 2, and 3 are all useful in various affections of the throat and chest. The spray-producer is used with any of the spray solutions mentioned on p. 919. The solution is put into the bottle, and the ball at the end of the tube is rapidly compressed and relaxed. The ball covered with netting is untouched by the hands. It is for the purpose of maintaining a steady stream. For sore throat the spray produced is useful. It may also be used for diffusing antiseptic solutions through a sick-room, or for spraying bed or body clothing with disinfecting solutions, or for diffusing perfume. It is also called an **atomizer.** Fig. 3 shows one kept working by steam. One fills the tin over the flame with water through the tube projecting above the handle. The solution —cold—is put in the bottle. This is used as an inhaler for inhaling medicated solutions. The person applies his mouth to the small end of the funnel-shaped piece, and breathes in the steam, which may be impregnated with terebene, eucalyptol, &c., by adding to the water in the bottle a few drops, 5 or 10, of any of these substances. Coghill's inhaler, fig. 2, is employed in lung affections. Between the double perforated wall is laid a piece of lint, cut to fit, and of a size large enough to cover all the openings. Five or ten drops of terebene or similar substance are sprinkled on the lint; the two parts are then pressed together, and the inhaler is put over the mouth, the band being fixed at the back of the neck. The person inhales by the mouth and breathes out by the nostrils. Maw's inhaler is shown in fig. 4. The vessel is half-filled with boiling-water, 5 or 10 drops of the eucalyptol, a tea-spoonful tincture of benzoin, or other material, are dropped in, the stopper is put in, and then the patient applies his mouth to the side piece and inhales the medicated steam. Fig. 5 shows an old form of enema syringe; the form commonly used is seen in Plate VIII. The **nasal douche** (fig. 6) is an arrangement of great value in treating chronic discharge from the nostril. It consists of 2 or 3 feet of india-rubber tubing of the size used for feeding bottles. At one end is attached a conically-shaped piece of bone or vulcanite with a channel bored through it for a nose-piece. At the other end is attached a piece of glass with a bend which dips into a glass of water, the bend passing over the edge of the glass. The glass is filled with the solution to be used for washing out the nostrils, and is set a foot or two above the head of the person, who applies his mouth to the nose-piece end, and by suction fills the india-rubber tube. The tube is now a syphon, and the water will continue to flow till the lower end of the tube in the glass is uncovered, or till the nose-piece end is raised up to the level of the glass. The flow being established, the person pinches the india-rubber tube to arrest it, till the nose-piece is adjusted. It is fitted into the *healthy nostril*, and the tube released. The person slightly stoops over a basin, and the water passes up one nostril to the back of the throat, flows into the posterior opening of the other nostril, down which it flows, washing the nostril, and is caught in the basin. Just at first the person will find a very little difficulty in preventing the water passing down the gullet, but by keeping the mouth open, and raising the palate by an action the person will speedily learn for himself, all this is prevented, and the washing process quite easily accomplished. A good solution to use to a pint of water is half a tea-spoonful of salt and the same quantity of bicarbonate of soda.

A **catheter** is not shown in the figure. It is an instrument for passing up into the bladder to draw off the urine. The only kind of catheter a patient should use on himself is a soft, flexible catheter, preferably the Mercier catheter, one with a bend near the point. The catheter is first dipped into warm water to make it quite flexible; it is then oiled with the finger, not dipped into oil, and then the person takes a short hold of the instrument and passes it gently into the urinary opening, passing it in bit by bit. After use it should be thoroughly cleaned by allowing warm water to pass through it. No one can do harm by using a flexible catheter, while a metal instrument may do very serious mischief in the hands of an unskilled person.

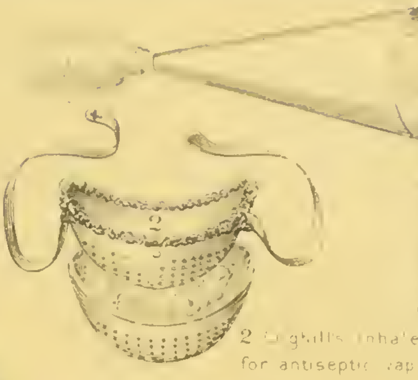
Fomentations.—Make a thick pad of flannel of the desired size, place it in a basin of boiling water, and when it is quite hot lift it out by means of a stick and throw it into a large towel. Let two persons seize the ends of the towel, one at each end, and twist them up, so wringing it and the flannel within it tightly. Apply it over the part, and cover it over with oiled silk or a thick pad of dry hot flannel. When frequent fomentations are needed, a potato steamer (Plate XIX., fig. 13) may be used for keeping them ready for use. A hot-water bottle is a convenient means of applying dry heat. It should always be enveloped in flannel to guard against burning, and the same with hot bricks, &c.

Poultices.—A poultice is usually made by heating a bowl with boiling water, placing in it the desired quantity of linseed-meal, pouring on boiling water and stirring till the required consistence is obtained. It is then spread on the cloth and covered by a layer of muslin, and applied as hot as can be borne. The writer has found that the number of people who can make a good hot poultice in this way is limited; and a half-cold poultice is worse than useless. On that account the directions he gives are as follows: Take a piece of flannel considerably longer than the poultice is to be, lay it on a board, an ironing board for instance, and set it in front of the fire to warm. Set a large dinner plate on the hot plate of the stove. Have a large basting needle and thread ready, also a piece of muslin to cover the face of the poultice; unfasten the patient's clothing so that everything is in readiness. Put the linseed-meal and water into a pot and bring to the boiling point, as one would do with porridge. When the mixture is of the consistence of porridge take off the pot, and pour the mixture on to the middle of the flannel; with rapid movements of a knife or spoon spread it evenly on the flannel to the desired size, and not too thickly. A very thick poultice is also very heavy. Lay over it the piece of muslin, fold down the edges of the flannel over the sides of the poultice, and quickly run a basting thread right round. Then double the poultice on itself, place it on the heated plate, cover it with warm flannel, and carry it to the patient. It will be so hot that there is plenty of time to adjust it. Place it on the desired part, cover with the piece of warm flannel, and fix it on firmly by a flannel binder. Remove it before it is cold. If it is not to be renewed, it may be slipped out from below the binder without disturbing anything else. For a mustard poultice the writer advises the same method. The linseed is put on the fire, and, when ready, a layer of it is spread on the flannel the desired size, but with only half of the linseed porridge. To the remainder in the pot the mustard is added, and, without putting the pot on the fire again, the two are thoroughly mixed. This mixture is now spread on the top of the first layer. That is to say, the poultice is in two layers, the layer next the flannel is without mustard, the layer above it is mixed with mustard, and is the layer that goes next the patient. The muslin is then laid on, and the rest of the process is as before. The usual quantity of mustard is 1 of mustard to 3 of linseed-meal, or equal parts of each. **Bran poultices** are made as linseed-meal poultices. **Bread poultices** are made with bread crumbs in sufficient quantity over which boiling water is poured till a sufficient consistence is obtained, the whole being thoroughly mixed into a soft mass. **Charcoal poultice:** Take 4 ozs. bread crumbs, 3 ozs. linseed-meal, 1 oz. powdered charcoal, 1 pint boiling water.

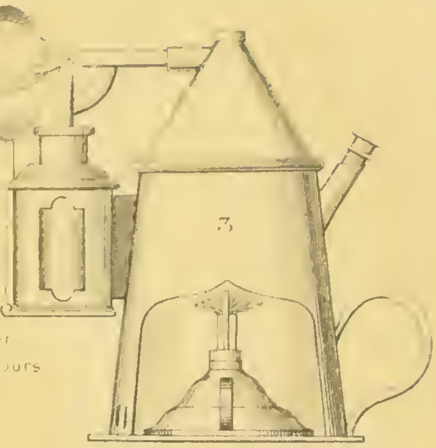
APPLIANCES FOR THE SICK ROOM.



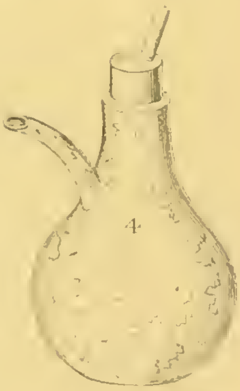
1 Spray Producer



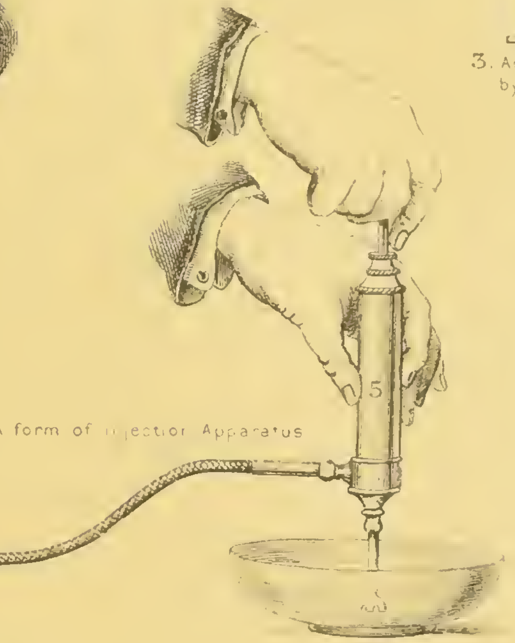
2 Coghill's Inhaler for antiseptic vapours



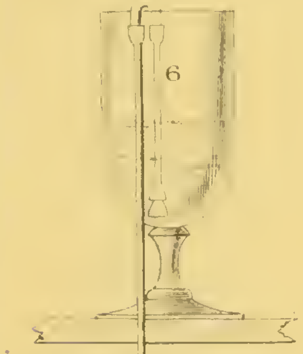
3. Adams' Inhaler– Spray produced by steam



4 Maw's Inhaler



5. A form of Injection Apparatus

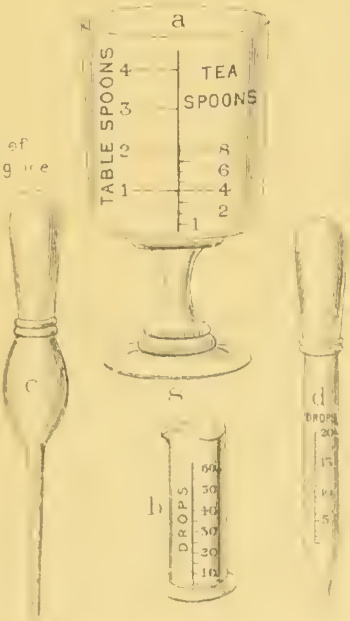


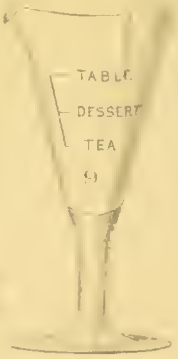
6 Arrangement of india-rubber tube and nose piece for washing out the cavity of the nostrils by a stream of water medicated or otherwise from a vessel placed above the person

7. Arrangement of glass for holding ice

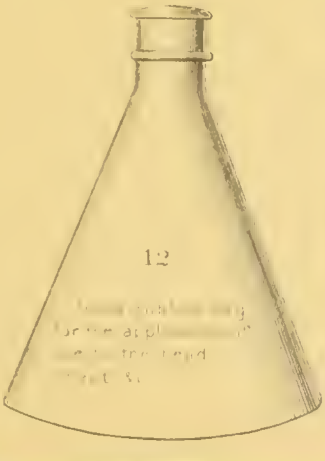
10 India-rubber tube [illegible] attached by a [illegible] to [illegible] the tumbler

11 Air-Cushion for relief of bed sores



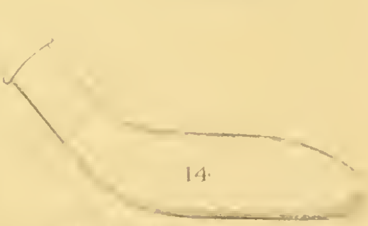


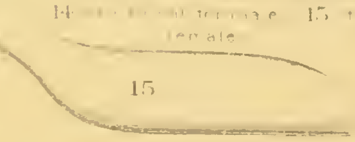
8 & 9 M[illegible] Measures a [illegible] [illegible] b c d [illegible]



[illegible] for the application [illegible] to the head [illegible]

13 [illegible] Steamer [illegible] supplying [illegible] for [illegible]





14 [illegible] for male. 15 for female

Mix the bread, meal, water, and half the charcoal in a warm bowl, spread on warm flannel, and sprinkle the remainder of the charcoal on the surface. It is used to disinfect and remove fœtor, for foul sores, bed-sores, &c.

Leeches are employed to draw fresh blood from the neighbourhood of an inflamed part, never to remove blood already effused. The small end of the leech is the mouth end. To apply it, wash and dry the part thoroughly. Meanwhile let the leech be swimming about in a vessel of water. When ready, take up the leech between the wet folds of a piece of clean lint and apply it to the desired part. It may be kept there by inverting over it a wine-glass. If several must be applied at once this is a suitable way of doing it. If the leech delays to bite, touch the part with a drop of sugar and water or milk. When the leech has withdrawn all it can, which usually occupies twenty minutes or more, it will drop off. When it does so put it into a vessel of water, a wide-mouthed bottle, for example, and cover the mouth very securely by a piece of cloth firmly tied below the edge. If a paper cover be used prick a few pin-holes in it. If the leech will not let go, do not pull it away, but sprinkle a few grains of salt upon it; it will relax its hold immediately. *Always be careful to dispose effectually of leeches that are no longer needed; and if leeches are being kept for any purpose, one cannot be too careful to have them securely fastened in their receptacle.* If they are carelessly tied up they will squirm their way out, and one cannot tell where ultimately they may wander, or what mischief they might succeed in doing. If it is desired to keep a leech bite bleeding, place a warm poultice over it; if it is desired to stop it, take a small piece of lint round the point of the finger and press firmly on the bite. Pressure with a thimble guarded by a piece of lint, will do. The bleeding will be stopped if pressure is kept up long enough. It is always proper to place a leech on a spot which can easily be compressed against a bone to stop the bleeding. For instance, a leech ought never to be put on the neck, nor over a vein. Glass tubes are provided to aid in the application of leeches.

Suppositories are small cones, like miniature sugar-loaves, made with cocoa butter and containing some active drug like morphia, belladonna, &c., for passing up into the bowel. They are quite easily introduced, specially if touched with oil. **Pessaries** are similar preparations, but larger, for the vaginal passage.

A FEW RECIPES FOR SICK-ROOM COOKERY.

1. **Beef-tea.** See p. 627.
2. **Peptonized Beef-tea.** See p. 847.
3. **Peptonized Milk, Sago, &c.** See p. 847.

4. Beef-tea with Oatmeal.

Mix two table-spoonfuls of oatmeal very smoothly with two spoonfuls of cold water, add a pint of strong beef-tea. Boil together for 5 or 6 minutes, stirring well all the time. Strain through a sieve and serve (*Ringer*). Arrowroot or corn-flour may be used instead of oatmeal, and needs no straining.

5. Beef-tea Pudding.

Stew 1 ounce of well-washed sago in half a pint of water till it is reduced to a half. Beat up one egg in a tea-cupful of cream, and slowly add this to the sago with constant stirring. Then add with constant stirring 4 tea-cupfuls of strong hot beef-tea.

6. Vegetable Soup.

Take two large peeled potatoes, an onion, and crumb up ½ lb. stale bread; put them into a quart of water and boil down to a pint. Strain and add a few sprigs of parsley and a small quantity of salt, and, if desired, pepper. Cover and allow to get cold. It may be warmed for use. When animal food is not allowed, this is a good article of diet (*Wood*).

7. Veal Jelly.

1 lb. lean veal, 1 breakfast-cupful of water, a piece of turnip the size of an egg, a pinch of salt. Slice the veal very thinly, and put it in a jar alternately with slices of the turnip cut very thinly, to which add the small pinch of salt and the water. Cover the jar very tightly with a paper, and put it in a saucepan of boiling water, coming more than half-way up the jar. Boil continuously for 4 hours. Then strain and use.

8. Bread Jelly.

Take the crumb of a loaf, break it up, pour boiling water over it, and leave it to soak for 3 hours. Then strain off the water and add fresh. Place the mixture on the fire and let it boil till it is perfectly smooth. Take it out, press out the water, flavour to taste, press it into a mould, and turn it out when it is required for use.

9. Port Wine Jelly.

To a pint of port wine in a jar add 1 ounce of the best gum arabic and 1 ounce fine gelatine, and a grated nutmeg. Let them stand an hour. Then put the jar into a sauce-pan over a slow fire till all is thoroughly dissolved. Add sugar according to taste. Strain it into a flat dish, and when it is nearly cold cut into squares.

10. Water Panada.

Put a pint of cold water and two slices of dry bread into a stew-pan and boil for three quarters of an hour, stirring occasionally. Add salt, stir in the yolk of an egg, flavour to taste, and serve.

11. Milk Panada.

To a tea-cupful of stale bread-crumbs add boiling water sufficient to cover them, and when they are soft mix thoroughly. Put the mixture into a pint of milk, boil and stir till it thickens. Sweeten, or add salt, and flavour according to taste.

12. Egg Nogg.

Best French brandy, 4 ounces; cinnamon water, 4 ounces; yolks of two eggs; sugar, ½ ounce. Rub the sugar and egg yolks together, then add the rest; or,

13.

Beat a whole egg for 5 minutes, adding a small quantity of sifted sugar and a cup of milk, warm or cold. To this may be added a small quantity of wine or brandy and a grated nutmeg. If milk is not desired, beat the egg and sugar together and add the wine or brandy.

14. Brandy and Egg Mixture. See Prescriptions, No. 63.

15. Oatmeal Gruel.

Put into a small basin a table-spoonful of Scotch oatmeal. After wetting it with a very little cold water, pour over it a pint of boiling water or milk, stirring all the time. Stir it for a few minutes, then allow it to settle one minute. Pour carefully into a clean sauce-pan all the liquid, and stir over the fire till it boils. Let it boil for 10 minutes, when it is ready for use. It may be sweetened with honey, sugar, or treacle; or it may be flavoured with salt and a small piece of butter. It should be taken very hot (*Mrs. Black*).—Or,

16.

Use the same quantity of oatmeal, a little more than half the quantity of boiling water, and salt to taste, and boil as directed. Then add half a pint of butter-milk, and a little bit of butter.

17. Black Currant Jam Water.

Two table-spoonfuls of jam are added to 4 tea-cupfuls of water in a sauce-pan and allowed to simmer for half an hour, and then strained. It may be drunk hot in cases of feverish sore throat, or after it has become cool for thirst.

18. Barley Water.

Wash 1 table-spoonful of barley, put it into a jug with the rind of one lemon and a tea-spoonful of sugar. Pour over it 3 tea-cupfuls of boiling water; then cover the jug and let it stand till cold. Pour off the liquid for use.

19. White Wine Whey.

To a breakfast-cupful of boiling milk add one or two wine-glassfuls of sherry. Strain through a fine sieve and sweeten with sifted sugar.

20. Oatmeal Water.

Put a large table-spoonful of oatmeal into a jug, and pour over it a pint of cold water. Stir well, allow the meal to settle. Then strain and use the water, flavoured if desired.

PRESCRIPTIONS.

The accompanying prescriptions are arranged in divisions in the following order:—

I. Tonic mixtures.
II. Purgative ,,
III. Diarrhœa ,,
IV. Fever ,,
V. Stimulant ,,
VI. Soothing ,,
VII. Cough ,,
VIII. Gargles, Mouth Washes, Tooth Powders.
IX. Liniments, Lotions, and Washes, including Eye Washes and Ointments, and Hair Washes.

In the prescriptions the weights and measures used are as follows:—

1 fluid ounce=8 fluid drachms.
1 fluid drachm=60 drops.
1 tea-spoonful means 1 fluid drachm or 60 drops.
1 dessert ,, ,, 2 ,, drachms or 120 ,,
1 table-spoonful means 2 dessert-spoonfuls or 4 tea-spoonfuls, and is equal to ½ fluid ounce.
The measure by weight is 60 grains 1 drachm, 8 drachms 1 ounce.

I.—TONICS.

Simple Acid Tonics.

1. *Dilute Hydrochloric Acid,*
Dilute Sulphuric Acid,
Dilute Nitro-Hydrochloric Acid, or
Aromatic Sulphuric Acid.

Any of these acids is useful as a general tonic in debility, in some forms of indigestion (see pp. 158 and 179), in looseness of bowels from catarrh (p. 179), in liver complaints (see p. 195), and similar disorders.

The dose is the same for each acid, namely, from 10 to 20 drops in a wine-glassful of water, taken after food. For a child 5 drops are sufficient. The aromatic sulphuric acid in water relieves thirst and checks profuse perspiration.

Acid Tonic with Quinine.

2.

Aromatic Sulphuric Acid,	6 *fluid drachms.*
Sulphate of Quinine, .	24 *grains.*
Syrup of Orange, . .	2 *ounces.*
Water, ...	*up to* 8 ,,

Dose: One table-spoonful in the same quantity of water thrice daily.

Useful in depressing disorders, see *Carbuncle* (p. 315).

Acid Tonic with Bark (Peruvian).

3.

Dilute Sulphuric Acid, ...	½ *ounce.*
Compound Tincture of Cinchona,	1½ *ounces.*
Syrup of Orange, ...	2 ,,
Infusion of Yellow Cinchona, up to	8 ,,

Dose: One table-spoonful in water twice or thrice daily with meals.

As a general tonic and in depressed states.

Bark as a Tonic.

4. Any of the *Cinchona Barks* in powder may be used alone as a tonic in doses of 15 grains, or the tincture in doses of ½ to 1 tea-spoonful in water. They are useful in checking looseness of bowels, sweating, &c.

5. *Tincture of Red Cinchona Bark* has a repute in allaying the craving for spirit of chronic drunkards (see p. 105).

Bitter Tonic.

6.

Tincture of Nux Vomica, .	8 *drops.*
Infusion of Chiretta, .	*up to* 4 *ounces.*

Dose: A fourth part taken before meals.

Useful as an aid in slow digestion.

Bitter Tonic with Ammonia or Soda.

7.

Aromatic Spirit of Ammonia, . .	½ *ounce.*
Compound Tincture of Cardamoms,	1 ,,
Infusion of Calumba, . .	*up to* 8 *ounces.*

Dose: A table-spoonful before meals.

8. Instead of the Aromatic Spirit of Ammonia *Bicarbonate of Soda or Potash* (80 *grains*) may be dissolved with the bitters.

Bitter Tonic with Acid.

9.

Dilute Hydrochloric Acid, . .	3 *drachms.*
Tincture of Nux Vomica, . .	40 *drops.*
Infusion of Chiretta, . .	*up to* 4 *ounces.*

Dose: A dessert-spoonful in a like quantity of water to be taken after meals.

These bitter tonics are all useful to rouse the stomach and aid digestion (see p. 179). The simple bitters, as well as those with ammonia, soda, or potash, should be taken immediately before meals, that with acid immediately after meals. The last is specially useful where indigestion is accompanied by sluggish and loaded liver (see p. 195), and in flatulent indigestion (see p. 181).

Simple Iron Tonics.

The simplest iron tonic is—

10. *Tincture of Steel.*

Dose: 10 drops in water five times daily.

It is useful in erysipelas (see p. 315), and in most conditions of ill-health dependent upon a poor quality of blood (see Anæmia, p. 234).

11. *Dialysed Iron.*

Dose: 5 to 15 drops in water four or five times daily.

Useful in weak conditions of body, rickets (see p. 30), and bloodlessness (anæmia, see p. 235). It is less binding to the bowels than tincture of steel.

Iron and Quinine.

12.	*Tincture of Steel,*	2½ *drachms.*
	Sulphate of Quinine,	48 *grains.*
	Syrup of Orange,	1½ *ounces.*
	Water,[1]	*up to* 4 „

Dose: A tea-spoonful in half a wine-glassful of water some time after food.

A good general tonic.

Iron, Quinine, and Strychnine.

13.	*Citrate of Iron and Quinine,*	90 *grains.*
	Liquor Strychniæ,	90 *drops.*
	Water,	*up to* 4 *ounces.*

Dose: A tea-spoonful in a table-spoonful of water thrice daily, an hour or more after food.

A good general and nerve tonic.

14. *Easton's Syrup* consists of a combination of iron, quinine, and strychnine, and is a useful tonic for debility.

The dose is a tea-spoonful in water.

The combinations with strychnine are useful in weak conditions, accompanied by nervous exhaustion and debility.

Iron and Arsenic.

15.	*Citrate of Iron and Quinine,*	2½ *drachms.*
	Liquor Arsenicalis,	60 *drops.*
	Tincture of Quinine,	2 *ounces.*
	Syrup of Orange,	2 „
	Water,	*up to* 8 „

Dose: A dessert-spoonful in two-thirds of a wine-glassful of water.

Useful in skin diseases (see p. 317), in impoverished conditions of the blood, see *Anæmia* (p. 235), and purpura (p. 237), in nerve affections, such as neuralgia (see p. 127).

Iron and arsenic are also extensively used in various diseases of women (see p. 509).

Iron and Phosphorus.

16.	*Reduced Iron,*	50 *grains.*
	Sulphate of Quinine,	25 „
	Phosphorus,	¼ *grain.*
	Extract of Nux Vomica,	13 *grains.*
	Extract of Gentian,	25 „

To be made into a pill mass and divided into 25 pills.

Dose: One pill thrice daily *on a full stomach.*

This is an exceedingly useful pill in most cases of nervous depression, nervous headache, neuralgia (p. 127), and nervous irritability, the result of exhaustion. On p. 113 the prescription for a stronger pill is given.

Iodide of Iron.

17. *Syrup of the Iodide of Iron* is the form in which this combination of drugs is usually ordered.

Dose: One half to one tea-spoonful in water three or four times daily. For very young children a quarter of a tea-spoonful is sufficient.

In all cases of illness associated with scrofula (p. 431) this is one of the best remedies. In scrofulous inflammation of bone (p. 26), scrofulous diseases of glands (p. 209), &c., it is very useful.

18. *Compound Syrup of the Phosphate of Iron* (Parrish's Syrup or Chemical Food), and

19. *Compound Syrup of the Hypophosphites,* are now both very extensively used for the treatment of cases of general debility, specially in the young. Various forms of No. 19 are now in the market, all more or less useful.

The dose in the case of any of these is from a third to one tea-spoonful (according to age) in water thrice daily a short time after food.

Iron and Chlorate of Potash.

20.	*Chlorate of Potash,*	90 *grains.*
	Dialysed Iron,	½ *ounce.*
	Syrup of Orange,	1½ *ounces.*
	Water,	*to* 4 „

Dose: A tea-spoonful in water four times daily.

Useful for those subject to relaxed throat (p. 157) or to attacks of inflamed tonsils.

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[1] Chloroform water instead of plain water would make this mixture more palatable.

II.—PURGATIVE MIXTURES AND PILLS.

Castor-oil.

21. Castor-oil may be taken as a safe purgative, at any time, in doses of from 2 to 3 tea-spoonfuls. Its taste may be entirely disguised by mixing it with a tea-cupful of beef-tea well peppered and salted. Or it may be mixed with half a tea-cupful of boiling milk. The boiling milk is gradually added in small quantities, being thoroughly stirred with the oil, till the oil is thoroughly incorporated with the milk, no large globules of oil being visible. *The milk must be boiling, and must be slowly added with constant stirring.*

Castor-oil and Laudanum.

22. *Castor-oil,*	1 *ounce.*
Tincture of Rhubarb,	1 *tea-spoonful.*
Laudanum,	15 *drops.*
Syrup of Orange,	1 *tea-spoonful.*
Cinnamon Water,	½ *ounce.*

Mix. The addition of two tea-spoonfuls of mucilage of gum arabic or gum tragacanth will permit of an emulsion being formed.

This mixture is very useful in looseness and irritability of bowels, due to irritating material in the bowel. After the opening effect is produced, clearing out the bowel, the soothing effect of the laudanum and the astringent action of the rhubarb come into play arresting further action.

This is only for adults.

Epsom Salts.

23. *Epsom Salts,*	½ *ounce.*
Acid Infusion of Roses,	2 *ounces.*

Add to any desired quantity of water. To be taken early in the morning.

This may be used for any feverish complaint, such as inflamed sore throat (p. 155) or feverish cold (p. 158) of the stomach.

Black Draught.

24. *Epsom Salts,*	4 *ounces.*
Rochelle Salts,	2 ,,
Essence of Senna,	7 ,,
Aromatic Spirit of Ammonia,	1 *ounce.*
Compound Tincture of Cardamoms,	1 ,,
Water,	16 *ounces.*

Take three or four table-spoonfuls in water early in the morning.

This is found to be a valuable purgative after a drinking bout, as a relief to the headache and stomach and liver disorder.

Seidlitz Powder.

25. *Rochelle Salts,*	120 *grains.*
Bicarbonate of Soda,	40 ,,

Dissolve in a tumblerful of water and then add 37 grains of tartaric or citric acid. Stir and drink during effervescence.

This is taken in the morning as a mildly opening draught.

Fruit Saline.

26. *Tartaric Acid,*	9 *ounces.*
Bicarbonate of Soda,	10 ,,
Chlorate of Potash,	¼ *ounce.*
Epsom Salts,	3 *drachms.*
Powdered Sugar,	3 *ounces.*

Or,

27. *Tartaric Acid,*	13 *ounces.*
Bicarbonate of Soda,	14 ,,
Chlorate of Potash,	½ *ounce.*
Epsom Salts,	2 *ounces.*
Sugar,	1½ ,,

Mix. Note each ingredient should be well dried before mixing.

These salines are useful as a mild opening medicine to be taken in early morning, 2 or 3 tea-spoonfuls in ½ tumblerful of water. In feverish states they may be safely taken by any one.

Lamplough's Pyretic Saline.

28. *Tartaric Acid,*	9 *ounces.*
Bicarbonate of Soda,	10½ ,,
Chlorate of Potash,	3 ,,

Mix. Use as above.

Calomel and Jalap.

29. *Calomel,*	5 *grains.*
Powder of Jalap,	15 ,,

Mix. Give in a little water; three hours later give the following draught:—

30. *Epsom Salts,*	¼ *ounce.*
Manna,	60 *grains.*
Tincture of Jalap,	2 *tea-spoonfuls.*
Cinnamon Water,	2½ *table-spoonfuls.*

This is the prescription for threatened affections of the head (see p. 101, inflammation of the membranes of the brain), and to reduce the stage of excitement that follows injuries to the head (see p. 104). It is also useful to relieve a loaded liver (p. 197, 198), and as an active purgative at the beginning of many acute diseases, inflammation of the kidney or lung for example.

Calomel and Rhubarb for Children's Powders.

31.	*Calomel,*	½ *to* 2 *grains.*
	Powdered Rhubarb,	3 *to* 8 ,,
	Aromatic Powder,	4 ,,

This may be given to children in cases of thread-worm (p. 174), in feverishness accompanying teething, and in head affections in children. For instance, if a child has had a fall or blow on the head it is well to give such a powder by way of preventive of nervous excitement following. The actual dose depends upon the age. The amount named would be suitable for children between 1 and 5 years, the smaller dose noted for the younger child.

Grey Powder and Soda for Children.

32.	*Grey Powder,*	½ *to* 3 *grains.*
	Carbonate of Soda,	6 ,,
	Sugar of Milk,	3 ,,

This is suitable for disordered states of the bowels in children where there is looseness of bowels, and the motions are curdy white, with pieces of undigested milk throughout. One morning and evening may be given.

In regard to grey powder the general rule for what are called "Cooling Powders" is, for a child between 1 and 6 months, ½ grain grey powder, 6 grains of the soda; for a child between 6 and 12 months, 1 grain grey powder, 6 of soda; between 1 and 3 years, 1½ grains grey powder, 6 soda; and between 4 and 8 years, 3 grains of grey powder with 6 of soda.

Jalap and Senna.

33.	*Compound Jalap Powder,*	30 *to* 60 *grains.*
	Syrup of Senna,	1 *tea-spoonful.*
	Camphor Water,	4 *table-spoonfuls.*

Mix and give in water early every morning. This promotes a watery discharge from the bowel, and is useful in dropsy consequent upon liver disorder (see p. 435).

Aloes.

34.	*Tincture (or Wine of Aloes),*	1 *tea-spoonful.*
	Infusion of Senna,	2 *table-spoonfuls.*
	Epsom Salts,	¼ *ounce.*

Mix and take in water in early morning.

The aloes acts principally on the large bowel, and is specially useful in habitual costiveness, with hard dry motions. The following is an excellent pill, containing the active principle of aloes, namely aloin, in cases of constant constipation, specially when it is due to want of sufficiently active exercise in the open air.

35.	*Aloin,*	*gr.* ⅕
	Extract Belladonna,	*gr.* ⅙
	Extract of Nux Vomica,	*gr.* ½
	Hard Soap,	*gr.* ½

Make into a pill. Let one such pill be taken either at bed-time, in which case it should act after breakfast next morning, or in early morning, in which case it should act after dinner.

Podophyllin.

36.	*Resin of Podophyllin,*	*gr.* ⅓
	Extract of Nux Vomica,	*gr.* ½
	Extract of Hyoscyamus,	*gr.* 1
	Hard Soap,	*gr.* ½

Make one pill. Take one such pill before breakfast each morning. This is a very suitable pill for sluggish liver and the costiveness that usually accompanies it (p. 195), and it relieves at the same time the indigestion and headache that are usually produced by it.

Rhubarb and Magnesia.

37.	*Carbonate of Magnesia,*	10 *grains.*
	Powdered Rhubarb,	5 ,,
	Aromatic Powder,	5 ,,

This is a suitable powder for feverish conditions in children and for disordered states of stomach and bowel (p. 460).

Another way of administering the same remedies to infants is as follows:—

38.	*Powdered Rhubarb,*	15 *grains.*
	Carbonate of Magnesia,	60 ,,
	Dill Water,	3 *table-spoonfuls.*

Give of this mixture a tea-spoonful every two hours till the bowels are freely opened.

Mixture for Gout.

39.	*Sublimed Sulphur,*	2 *ounces.*
	Cream of Tartar,	1 *ounce.*
	Powdered Rhubarb,	¼ ,,
	Resin of Guaiac Powder,	1 *drachm.*
	Honey,	1 *pound.*
	One Nutmeg reduced to powder.	

Mix thoroughly.

This is a mixture formerly in much repute for gout and chronic rheumatism, and was well known under the name of the "Chelsea Pensioner." The dose is 2 tea-spoonfuls night and morning till the whole is consumed.

III.—DIARRHŒA MIXTURES.

The few mixtures for diarrhœa that will be mentioned here are not to be given at random. Let the reader refer to Diarrhœa (p. 184), and to the paragraphs on Remedies for Diarrhœa (p. 866). It is possible that by acting on the instructions given there, the looseness of bowels may be checked without the use of any astringent remedies, which by their binding effect tend to cause costiveness afterwards. The following prescriptions are to be resorted to only if simpler means fail, or if pain, griping, and excessive discharge make the case urgent:—

Bismuth and Ipecacuanha.

40.

Carbonate of Bismuth, . . .	10 *grains.*
Powder of Ipecacuanha, . .	5 ,,

Mix. Give one powder every two or three hours, till the diarrhœa is checked.

Bismuth, Ipecacuanha, and Opium.

41.

Carbonate of Bismuth, . . .	10 *grains.*
Dover's Powder (Compound Ipecacuanha Powder, which contains 1 grain opium in 10 of powder), ...	5 ,,

Mix. Give one powder every four hours if necessary.

Catechu and Chalk Mixture.

42.

Tincture of Catechu,	½ *ounce* (1 *table-spoonful*).
Oil of Peppermint, . .	6 *drops.*
Aromatic Chalk Powder,	90 *grains.*
Chalk Mixture, . .	*to* 8 *ounces.*

Give an eighth part after each loose motion. If this treatment fail, add 8 drops of laudanum to each dose.

It is well to make certain, before giving this mixture, that no irritating material is lodging in the bowel by administering a table-spoonful of castor-oil three or four hours before the mixture is begun, if the case is not too urgent.

43. Ipecacuanha Powder used in large doses, as detailed on p. 852, is given in the Tropics for dysentery.

44.

Liquid Extract of Bael Fruit, ...	1–2 *tea-spoonfuls.*
Syrup of Red Gum, . .	1 *tea-spoonful.*
Water, ...	1 ,,

Mix. This is recommended for chronic dysentery (p. 186) given three or four times a day.

Diarrhœa Mixtures for Children.

45.

Carbonate of Bismuth, .	80 *grains.*
Ipecacuanha Wine, . .	80 *drops.*
Aromatic Spirit of Ammonia, ...	1½ *tea-spoonfuls.*
Simple Syrup, . . .	½ *ounce* (1 *table-spoonful*).
Mucilage of Gum Arabic,	½ *ounce.*
Water, ...	*to* 2 *ounces.*

Mix. Give a tea-spoonful every three hours to a child 1 year old, and half the quantity to a 6-months'-old child. If it were absolutely necessary, one drop of laudanum might be added to the dose for the year-old child. But this should not be done unless medical advice is not within reach.

46.

Aromatic Powder of Chalk and Opium, ...	20 *grains.*
Carbonate of Bismuth, . . .	60 ,,

Mix and divide into 10 powders. One of these could be given every third hour to a child 1 year old. Note that in aromatic chalk and opium powder there is ½ grain of opium in the 20 grains of the powder, so that in each of the 10 powders there would be $\frac{1}{20}$th grain of opium.

Diarrhœa with Blood in the Motions.

47. The *Catechu and Chalk* mixture (No. 42) may be used with the addition to each dose of 5 drops tincture of witch-hazel or *Hamamelis virginica* (p. 835), or 1 tea-spoonful of the American preparation, Pond's extract, or the same quantity of the English preparation, hazeline. The following may also be taken:—

48.

Tincture of Steel (steel drops), ...	15 *drops.*
Dilute Hydrochloric Acid,	10 ,,
Orange Flower Water,	3 *table-spoonfuls.*

Mix and take the whole quantity in water, to be repeated every 6 hours.

The same may be used in bleeding from the stomach. See also p. 835.

IV.—FEVER MIXTURES.

Quinine.

49. *Quinine* is often the best drug to use in cases where there is considerable fever. It is sometimes best given alone, simply stirred in a wine-glassful of cold water.

Dose: 3 to 5 grains every 4 or 6 hours.

In cases where the fever heat is very great, such as cases of acute inflammation of glands (p. 207), or of blood poisoning (p. 236), or in cases of ague (p. 427), a large dose should be given at once, namely:

10 grains, and it may be repeated in six hours.

Salicine.

50. *Salicine* or Salicylate of Soda is one of the most quickly acting remedies in rheumatic fever (p. 430).

Dose: 20 grains in water every two hours till the pains are relieved. Thereafter four doses daily for several successive days.

Quinine and Salicine.

51. *Quinine,*	5 *grains.*
Salicine, ...	20 ,,

This makes one powder to be given all at once.

This is a combination useful in some feverish conditions. It is specially useful in neuralgic affections (p. 127).

52. *Antipyrin* and its use in fever is sufficiently detailed on p. 821.

Dover's Powder.

53. *Dover's Powder* is useful at the very outset of a feverish cold (see *Catarrh*, p. 154, and *Cold in the Stomach*, p. 158), inflammation of the bowels (p. 162), and childbed fever (p. 518).

Every 10 grains of the powder consist of

Powdered Opium, ...	1 *grain.*
Powdered Ipecacuanha, . . .	1 ,,
Sulphate of Potash, ...	8 *grains.*

Dose: 10 grains given in water.

It must never be given to children.

Acetate of Ammonia.

54. *Liquor Acetate of Ammonia,* . .	5 *ounces.*
Simple Syrup, ...	1½ ,,
Water, ...	*to* 8 ,,

Dose: From a tea-spoonful (for children) to a table-spoonful (for adults) in water every three hours.

Used in all feverish diseases, especially in those accompanied by skin eruption. It promotes sweating and this reduces the fever.

Ammonia and Ether.

55. *Liquor Acetate of Ammonia,* .	3 *ounces.*
Spirit of Nitrous Ether, . . .	1 *ounce.*
Simple Syrup, ...	1 ,,
Water, ...	*to* 6 *ounces.*

Dose: From a tea-spoonful to a table-spoonful (according to age) in water every three hours.

Useful in the beginning of most fevers.

Another prescription for Ammonia and Ether is given on p. 402.

V.—STIMULANT MIXTURES.

Ammonia.

56. *Carbonate of Ammonia,* . . .	80 *grains.*
Syrup of Ginger, ...	1 *ounce.*
Water, ...	*to* 4 *ounces.*

Dose: Two tea-spoonfuls in water every four hours.

Useful in faintness, wind on the stomach (p. 243), in nervous and hysterical persons, and as a general stimulant.

Ammonia and Ether.

57. *Carbonate of Ammonia,* . .	120 *grains.*
Chloric Ether, ...	3 *drachms.*
Infusion of Senega, . . .	6 *ounces.*

Dose: A dessert-spoonful in a wine-glassful of water every three hours.

A valuable stimulant in chronic bronchitis (p. 271), and in exhaustion in cases of inflammation of the lungs (p. 275), and other weakening diseases, such as typhoid fever.

58. *Aromatic Spirit of Ammonia,*	1½ *ounces.*
Chloric Ether, ...	2½ *drachms.*
Syrup of Ginger, ...	1 *ounce.*
Water, ...	*to* 4 *ounces.*

Dose: A dessert-spoonful in a wine-glassful of water as required.

May be used for faintness, and giddiness in nervous people troubled with wind on the stomach (p. 181). The same is useful in hiccup (p. 182) and palpitation, and is aided by the addition to each dose of 10 drops of spirit of camphor, or the mixture may be made up to 4 ounces with camphor water instead of simple water. With the addition of camphor the mixture is useful in looseness of bowels (p. 184), and in tea-spoonful doses might be given to children.

59. *Aromatic Spirit of Ammonia,*	½ *tea-spoonful.*
Carbonate of Magnesia, .	20 *grains.*
Spirit of Chloroform, . .	½ *tea-spoonful.*
Peppermint Water, .	*to* 1½ *ounces.*

Make a draught with water. To be taken all at once for colic, hysterical faintness, flatulence, &c.

60. Stimulant Mixture for children with wind on the stomach and colicky pain.

Carbonate of Magnesia, . .	60 *grains.*
Sugar of Aniseed, ...	60 ,,
Aromatic Spirit of Ammonia,	30 *drops.*
Compound Tincture of Cardamoms, ...	2 *drachms.*
Dill Water, ...	*to* 2 *ounces.*

Mix. A tea-spoonful for a dose, repeated as required.

Caffein and Guarana—Nerve Stimulants.

61. The active principle of coffee—caffein—and the active principle of the Brazilian cocoa—guarana—are useful nervous stimulants in certain cases. They are frequently used in nervous headache.

The caffein is given in doses of 1 to 5 grains in water, or may be obtained as effervescing citrate of caffein, of which a tea-spoonful in half a tumbler of water is the dose, and it may be frequently repeated.

The dose of guarana is 15 to 30 grains given in water, and repeated for a time every two hours if necessary.

Ether and Brandy.

62. *Chloric Ether,*	3 *drachms.*
French Brandy, ...	1½ *ounces.*
Infusion of Yellow Cinchona,	*to* 8 „

Dose: Two table-spoonfuls to be given occasionally.

In convalescence from acute diseases or in low fevers.

Brandy and Egg Mixture.

63. Beat up an egg till it froths, add a lump of sugar and two table-spoonfuls of water, mix well; pour in half a small wine-glassful of brandy, or, instead, one wine-glassful of sherry, and administer before it gets flat.

Useful in convalescence from exhausting diseases.

Brandy and Milk.

64. Pour a table-spoonful of brandy or a wine-glassful of sherry into a cup, add a little powdered sugar and very little nutmeg to taste. Warm a breakfast-cupful of new milk and pour it into a jug with a spout. Pour the milk from a height into the cup containing the brandy or wine. The milk must not be boiled.

Beef and Iron Wine.

65. Several chemists now make a preparation of beef, wine, iron, or meat and malt wine, &c.

These are useful in weak states of health, and often very useful in exhausting diseases of children.

The Beef and Iron Wine of Burroughs Welcome & Co., and the Extract of Meat and Malt Wine of Coleman, are illustrations.

VI.—SEDATIVE (SOOTHING) MIXTURES.

66. *Bromide of Potassium* is one of the simplest and safest (if not used with unnecessary frequence) of soothing drugs.

Dose: For adults, ...	30 grains.
For young children, . .	5 „

It should be dissolved in sweetened water.

It is exceeding valuable in many nervous diseases, especially epilepsy (p. 123), inflammation of the brain (p. 100) and spinal cord (p. 117), child-crowing (p. 464), somnambulism (p. 116), and sometimes sick-headache and neuralgia.

67. *Belladonna* is also very serviceable in nervous diseases, especially spasmodic diseases, such as epilepsy (p. 123). It is one of the best remedies in whooping-cough (p. 416).

At the places referred to directions are given for the use of the drug.

68. *Extract of Belladonna,* . . .	⅙ *grain.*
Extract of Hyoscyamus (*Henbane*),	1½ *grains.*
Extract of Gentian, ...	1 *grain.*

To be made into one pill.

Dose: One pill, to be repeated twice or thrice within eight hours if required.

Useful in allaying irritation of bowels and bladder (p. 305).

69. *Extract of Indian Hemp* (*Cannabis Indica*), ...	1½ *grains.*
Extract of Henbane, ...	6 „
Extract of Gentian, ...	6 „

Make into a pill mass and divide into six pills.

Dose: One pill repeated thrice or four times daily if necessary.

This is extremely soothing in sick-headache (p. 113), in various painful diseases of women (p. 510 and 504). It is also used for sleeplessness (p. 117). In such a case the dose should not be larger than ¼ grain of the Indian Hemp to begin with.

Opium or its chief active principle morphia is one of the most powerful of soothing remedies. One mixture containing it will, therefore, be given.

70. *Liquor Hydrochlorate of Morphia,*	½ *ounce.*
Tincture of Hyoscyamus, . .	1 „
Syrup of Orange, ...	1 „
Water, ...	*to* 4 *ounces.*

Dose: A dessert-spoonful in water, to be repeated in two or three hours, only if necessary.

This mixture is likely to relieve most painful affections of the stomach and bowels, many spasmodic diseases, spasmodic cough, &c. *It ought not to be given for cough when any defluxion is brought up by coughing, and it ought never to be given to children.*

VII.—COUGH MIXTURES.

A separate paragraph relating to cough mixtures is given here mainly to warn persons against the indiscriminate use of the ordinary mixtures. Cough is certain to exist wherever there is phlegm or matter in the air-tubes, and is the natural method of expelling the offending material. To stop cough, in such cases, is certain to do harm by causing the material to remain and accumulate in the lungs or air-passages. In such cases the proper treatment is to give medicine which will aid the expulsion of the material, and thus relieve the cough. But, in the second place, the cough may be due to irritability of the air-passages without the presence of any material to be expelled. In such cases soothing drugs are needed. For further details see p. 284. The difference may be put by calling the first class of cases that of cough with spit and the second class that of dry cough.

For Cough with Spit.

71. *Ipecacuanha Wine* 5 to 40 drops, according to age, in a table-spoonful of water.

Useful in rendering the defluxion more fluid so that it is more readily expelled.

72.

Carbonate of Ammonia, . . .	16 *grains.*
Ipecacuanha Wine, ...	80 *drops.*
Camphor Water, ...	to 4 *ounces.*

A dessert-spoonful every two or three hours.

Useful *for children* to aid the expulsion of matter from the air-tubes in bronchitis, whooping-cough, &c.

73.

Carbonate of Ammonia, . . .	40 *grains.*
Spirit of Ether, ...	2 *drachms.*
Tincture of Squill, . . .	1½ „
Tincture of Camphor, . . .	2 „
Infusion of Senega, . .	to 4 *ounces.*

Mix: Give one table-spoonful in water every four hours.

Useful for helping the cough in the bronchitis of *old people.*

For Dry Cough.

74. *Ipecacuanha Wine* may be used as directed for cough with spit. It often gives great relief when sprayed into the back of the throat by means of the spray producer (see Plate of Appliances for the Sick-room). A few drops of the wine added to some honey and water would make a soothing mixture for children, or liquorice juice might be employed for the same purpose.

75. A very useful cough mixture when the cough is the result of irritability of the air-passages will be found under Sedative (Soothing) Mixtures, No. 70. It should not be given to children.

No cough mixture containing laudanum, or other preparation of opium, such as paregoric elixir, or a drug like chlorodyne, should be given to children without a physician's orders.

VIII.—GARGLES AND MOUTH WASHES AND TOOTH POWDERS.

Borax Gargle.

76.

Borax, ...	¼ *ounce.*
Tincture of Myrrh, ...	1 „
Water, ...	*to* 8 *ounces.*

Mix. Gargle the mouth with a small quantity added to an equal quantity of lukewarm water twice daily in cases of ulcers about the mouth and throat (p. 149), or in relaxed sore throat and inflammation of tonsils (p. 155).

Borax and Glycerine.

77.

Borax, ...	¼ *ounce.*
Glycerine, ...	1 „

Dissolve and apply with a brush in cases of ulcers and cracks of tongue, sore throat, &c. (p. 155).

Alum Gargle.

78.

Burnt Alum, ...	80 *grains.*
Tincture of Myrrh, ...	1 *ounce.*
Water, ...	*to* 7 *ounces.*

Mix. Apply this to the gums, mouth, throat, &c., in cases similar to above.

Alum and Catechu Gargle.

79.

Burnt Alum, ...	90 *grains.*
Tincture of Catechu, . .	1 *ounce.*
Tincture of Cayenne, . .	1 *tea-spoonful.*
Glycerine, ...	1 *ounce.*
Water, ...	*to* 4 *ounces.*

Mix. This is a very useful gargle in cases of relaxed sore throat, in which case diluted with an equal quantity of warm water it may be used several times a day. It may also be applied, full strength, by means of a camel's-hair pencil at the very onset of an inflamed sore throat.

Tannic Acid Gargle.

80.

Tannic Acid, ...	90 *grains.*
Tincture of Myrrh, ...	½ *ounce.*
Glycerine, ...	1 „
Water, ...	*to* 4 *ounces.*

Mix. In cases of relaxed sore throat, ulceration of mouth, loosening of teeth, spongy gums, this is useful diluted with three times the quantity of warm water, or applied, half strength, by a camel's-hair pencil.

Carbolic Acid and Myrrh Mouth Wash.

81.

Carbolic Acid (Calvert's, No. 2),	½ *ounce.*
Tincture of Myrrh and Borax, .	½ ,,
Glycerine, ...	2 *ounces.*
Water, ...	1 *ounce.*

Mix. About half a tea-spoonful of the mixture in a third of a tumblerful of warm water makes a most soothing and pleasant mouth wash. It is valuable for decaying teeth and spongy gums, removes offensive odour from the breath, and is effective in removing the smell of smoke from the breath.

Chlorate of Potash Mouth Wash.

82.	*Chlorate of Potash,*	¼ *ounce.*
	Tincture of Myrrh, ...	½ „
	Glycerine, ...	1 „
	Water, ...	*to* 4 *ounces.*

Mix. This diluted with three or four parts of water may be used for sore throat, as a gargle, ulcerated mouth, &c.

Iron and Glycerine Gargle.

83.	*Tincture of Steel,*	1 *ounce.*
	Glycerine, ...	1 „
	Rose Water, ...	1½ *ounces.*
	Water, ...	*to* 4 „

Mix. Diluted with equal parts of water this may be used as a gargle for sore throat, or applied full strength by a camel's-hair pencil, or diluted with three or four parts of water it may be sprayed into the throat with a spray-producer for hoarseness.

Antacid and Astringent Tooth Powder.

84.	*Precepitated Chalk,*	5 *ounces.*
	Magnesia, ...	1½ „
	Orris Root Powder, ...	½ *ounce.*
	Sugar, ...	½ „
	Tannic Acid, ...	30 *grains.*
	Oak Bark in Powder, . . .	5 „
	Powdered Hard Soap, . . .	¼ *ounce.*
	Otto of Roses, ...	10 *drops.*
	Oil of Lemon, ...	2 „

Mix.

Camphorated Chalk Tooth Powder.

85.	*Camphor,*	1½ *ounces.*
	Orris Root Powder, ...	½ *ounce.*
	Precipitated Chalk, ...	½ *lb.*

Mix.

Antiseptic Tooth Powder.

86.	*Powdered Castile Soap,* . . .	60 *grains.*
	Precipitated Chalk, ...	2 *ounces.*
	Eucalyptus Oil, ...	60 *drops.*
	Carbolic Acid, ...	30 „

Mix thoroughly.

IX.—LINIMENTS, LOTIONS, AND WASHES.

Camphor Liniment.

87.	*Camphor,*	1 *ounce.*
	Olive or Cotton-seed Oil, . . .	4 *ounces.*

Crush the camphor and set it aside in the oil till it is dissolved.

Soap Liniment (Opodeldoc).

88.	*Hard Soap,*	2½ *ounces.*
	Camphor, ...	1¼ „
	Oil of Rosemary, . . .	3 *fluid drachms.*
	Rectified Spirit, . . .	18 *fluid ounces.*
	Water, ...	2 „ „

Crush the soap and camphor and mix with the spirit and water, finally add the oil of rosemary.

Soap and Opium Liniment.

89.	*Liniment of Soap,* . .	*of each* 1 *ounce.*
	Tincture of Opium, . . (*Laudanum*).	

This is also frequently called opodeldoc. It is useful as a stimulating liniment for sprains, bruises, stiff joints, &c., *after all pain has ceased.* Sprinkled on flannel and applied to the throat it is useful in sore throat, hoarseness, and for the relief of cough. For sprains 1 tea-spoonful tincture of arnica may be added.

Ammonia and Camphor Liniment.

90.	*Ammonia Water* (*Spirit of Hartshorn*), ...	1 *tea-spoonful.*
	Liniment of Camphor, . .	1 *ounce.*

The above liniment is useful as a stimulant, for friction to the chest, stiff joints, rheumatic joints, &c.

Turpentine Liniment.

91.	*Oil of Turpentine,*	4 *ounces.*
	Camphor, ...	¼ *ounce.*
	Soft Soap, ...	½ „

Mix. This is employed as a stimulating liniment in cases mentioned under No. 90, and 3 ounces of it mixed with 5 of camphor liniment are used as a liniment for the chest in cases of chronic bronchitis, pain in the chest, and for sore-throat, hoarseness, &c.

Chilblain Liniment (Wardrop's).

92.	*Tincture of Cantharides* (*Spanish-fly*), ...	3 *drachms.*
	Soap Liniment, ...	9 „

Soothing Liniment.

93.	*Liniment of Aconite,*	*of each 1 ounce.*
	Liniment of Belladonna,	
	Liniment of Chloroform,	

Mix. This is a very soothing mixture for rubbing on painful joints, rheumatic joints, for neuralgia, for pain in the back or side. (See p. 919.)

The liniments of aconite and belladonna are made by taking 20 ounces of the aconite or belladonna root, bruising and rubbing it into a coarse powder, and letting it steep for several days in rectified spirit, during which the mixture is frequently shaken up. Then the liquid portion is drained off, and the refuse washed with spirit. The total quantity obtained should be 20 fluid ounces. Finally an ounce of camphor is added.

The liniment of chloroform is made with two fluid ounces of chloroform, and two of liniment of camphor (No. 87).

Liniment of Lime (Carron-oil).

94.	*Lime Water,*	1 *ounce.*
	Olive, Linseed, or Cotton-seed Oil,	1 ,,

Mix. This is a most soothing application to burns (p. 999).

The lime-water is made with 1 ounce slaked lime, and 80 ounces (4 pints or ½ gallon) distilled water. Keep it in a stoppered bottle, and draw off the clear solution as required. The lime is slaked as follows: take 1 ounce fresh lime, add 1 fluid ounce boiling water and then 30 ounces cold water, and stir occasionally for half an hour. Allow it to stand an hour, carefully pour off the water. The white deposit remaining is the slaked lime. Lime-water may be straightway made from it by adding 30 ounces distilled water, stirring the mixture well for a time, then allowing the coarser particles to settle, and pouring off the watery portion into a stoppered bottle, where it stands till clear. The clear water is then used as required.

Lotions for Wounds.

95. These have been sufficiently indicated on p. 917 and p. 971.

Eye Lotions.

Chamomile-tea Wash.

96.	*Chamomile Flowers,*	½ *ounce.*
	Boiling Water,	10 *ounces* (½ *pint*).

Infuse for half an hour and strain.

This is a very mild eye wash. It may be diluted with lukewarm water for use. If a stronger solution is required, as when the eyes are mattering, one of the following three may be substituted:—

97.	*Sulphate of Zinc,*	2 *grains.*
	Water,	1 *ounce.*

Or,

98.	*Alum,*	2 *grains.*
	Water,	1 *ounce.*

Or,

99.	*Bichloride of Mercury,*	1 *grain.*
	Water,	2 *ounces.*

Dissolve. This is still further diluted for use with two or three times the quantity of water.

NOTE.—*It is very poisonous, and must be kept out of the range of being accidentally used for internal medicine.*

Any of these four may be used as a wash for inflamed conditions of the eyelids. (Refer to *Conjunctivitis,* p. 368). When there is fear of light to any extent, and the eye cannot be opened to the light, such should not be used, but the atropine drops employed and the other treatment recommended under inflammation of the cornea (p. 371).

Eye Ointment.

100.	*Yellow Precipitate,*	8 *grains.*
	Vaseline or Lard,	1 *ounce.*

Mix with the aid of heat. A stronger ointment with the same ingredients is mentioned on p. 367.

101.	*Weak Citrin Ointment,*	1 *drachm.*
	Vaseline or Lard,	7 *drachms.*

Mix. This is very suitable for applying to the edges of inflamed and thickened eyelids with inflammation round the lashes (see p. 367).

Hair Wash.

102.	*Aromatic Spirit of Ammonia,*	1 *ounce.*
	Spirit of Rosemary,	1 ,,
	Glycerine,	1 ,,
	Tincture of Cantharides (Spanish-fly),	½ ,,
	Rose Water,	*to* 8 *ounces.*

Mix. This is to be applied to the roots of the hair with a piece of sponge or a fine brush, when the hair is falling off.

Erasmus Wilson's Hair Wash.

103.	*Strong Liquor Ammonia,*	1 *ounce.*
	Spirit of Rosemary,	3 *ounces.*
	Tincture of Cantharides,	1 *ounce.*
	Almond Oil,	1 ,,
	Lavender Water,	2 *ounces.*

Use as directed for No. 102.

GLOSSARY.

Abdomen (Lat. *abdere*, to conceal), the belly, pp. 130, 138.

Abortion (Lat. *abortio*), a miscarriage, p. 513.

Abrasion (Lat. *ab*, off, and *rado*, I rub), removal of the protecting surface of the skin, p. 974.

Abscess (Lat. *abscedere*, to separate), a collection of matter, pp. 28, 209.

Absorption (Lat. *absorbere*, to suck up), the process by which materials are taken up by vessels in the body, pp. 201, 204.

Acetabulum (Lat. *acetum*, vinegar) means a vessel for holding vinegar. Applied to the socket into which the upper end of the thigh-bone fits to form the hip-joint, p. 22.

Acholia (Gr. *a*, not, and *cholē*, bile), absence of bile, p. 199.

Acromion (Gr. *akros*, high, and *omos*, the shoulder), the process of the shoulder blade which forms the point of the shoulder, p. 21.

Acute (Lat. *acutus*, sharp), applied to disease running a rapid course with severe symptoms, p. 4.

Adenitis (Gr. *adēn*, a gland), inflammation of glands, p. 207.

Adenoid (Gr. *adēn*, a gland), gland-like, p. 201.

Adipose (Lat. *adeps*, fat), applied to fatty tissue, p. 17.

Aeroscope (Gr. *aēr*, the air, and *skopeō*, I examine), an instrument for determining the presence of particles in the air, p. 685.

Ætiology (Gr. *aitia*, a cause, and *logos*, a discourse), the branch of medical science which deals with the causes of disease, p. 4.

Afferent (Lat. *ad*, to, and *fero*, I carry), nerves or vessels which convey impressions or blood or lymph towards the centre of the body, p. 291.

Agraphia (Gr. *a*, not, and *graphō*, I write), loss of power of writing, p. 120.

Albumin (Lat. *album*, white), a substance of which white of egg is a type, p. 132.

Albuminuria (Lat. *albumin*, from *album*, white, and Gr. *ouron*, the urine), albumin in the urine, p. 295.

Algide (Lat. *algeo*, to be very cold), applied to a stage of cholera, p. 188.

Alkalies (Arabic, *al*, essence, and *kali*, the plant from which soda was first obtained), compounds of certain metals, soda, potash, &c., which neutralize acids, p. 844.

Alkaloid (*alkali*, which see, and Gr. *eidos*, likeness), certain complex nitrogenous principles found in plants, such as morphia, strychnia.

Alopecia (Gr. *alopex*, a fox, in which partial loss of hair is common), loss of hair, p. 329.

Alteratives (Lat. *alter*, another), remedies which modify nutritive processes in the body, p. 822.

Alveolus, pl. **Alveoli** (Lat. *alveus*, a trough), applied to the sockets of the teeth and the air-cells of the lung, p. 252.

Amaurosis (Gr. *amauroō*, I darken), loss of sight, partial or complete, p. 378.

Amblyopia (Gr. *amblus*, dulled, and *ōps*, eye), defective vision, p. 378.

Amenorrhœa (Gr. *a*, absence of, *mēn*, the month, *reō*, I flow), absence of the monthly illness, p. 508.

Amnesia (Gr. *amnēsia*, forgetfulness), loss of memory of words, p. 120.

Amnion (Gr.), the membranous sac enclosing the fœtus, p. 485.

Amœba (Gr. *ameibō*, I change), an elementary organism, p. 214.

Ampulla (Lat. *ampulla*, a flask), a dilated portion of a canal, p. 358.

Amyloid (Lat. *amylum*, starch), starch-like, p. 200.

Anæmia (Gr. *a*, without, and *haima*, blood), the condition of poverty of blood, pp. 103, 215.

Anæsthesia (Gr. *a*, not, and *aisthanomai*, I perceive), loss of feeling, p. 118.

Anæsthetics (see above), substances which abolish sensation, p. 904.

Anasarca (Gr. *ana*, through, and *sarx*, flesh), a term for dropsy, p. 435.

Anatomy (Gr. *ana*, apart, and *temnō*, I cut), the science which deals with the structure of organized bodies, p. 15.

Anchyloblepharon (Gr. *ankulē*, a thong, and *blepharon*, the eyelid), adhesion of eyelids to one another, p. 369.

Anchylosis (Gr. *ankulos*, curved), the stiffening and fixing of a joint by disease, p. 33.

Aneurism (Gr. *aneurunō*, to widen), a tumour formed by dilatation of an artery, p. 244.

Angeioma (Gr. *angeion*, a blood-vessel), a blood-vessel tumour, p. 247.

Angina (Lat. *angina*, from *ango*, I strangle), an affection of the heart accompanied by a paroxysm of pain, p. 243.

Angioleucitis (Gr. *angeion*, a vessel, *leukos*, white, and termination *itis*), inflammation of lymphatic vessels, p. 206.

Anodynes (Gr. *a*, without, and *odunē*, pain), remedies for the relief of pain, p. 897.

Anorexia (Gr. *an*, negative, and *orexis*, appetite), want of appetite, p. 146.

Anosmia (Gr. *a*, not, and *osmē*, smell), loss of sense of smell, p. 366.

Antacids (Gr. *anti*, against, and Lat. *acidus*, acid), remedies which neutralize acids, pp. 839, 843.

Anthelmintic (Gr. *anti*, against, and *elmins*, a worm), remedies against worms, p. 871.

Anthrax (Gr. *anthrax*, a coal or carbuncle), an infectious disease specially attacking animals, but communicable to man, p. 315.

Anthropometry (Gr. *anthrōpos*, a man, and *metron*, a measure), the measurements of the physical proportions of the body, strength, weight, height, &c., p. 467.

Antidote (Gr. *anti*, against, and *didōmi*, to give in return), a medicine which counteracts the effects of a poison or destroys it, p. 1018.

Antifebrile (Gr. *anti*, against, and Lat. *febris*, fever), applied to remedies for fever, p. 820.

Antiperiodic (Gr. *anti*, against, and *periodos*, a period), remedies for diseases which have increase or return at regular intervals, such as ague, p. 823.

Antiphlogistic (Gr. *anti*, against, and *phlōgōsis*, heat), a remedy for fever, p. 820.

Antipyretic (Gr. *anti*, against, and *puretos*, fever), remedies for fever, p. 819.

Antiseptic (Gr. *anti*, against, and *sēpō*, I make putrid), substances which prevent putrefaction, p. 395.

Antispasmodics (Gr. *anti*, against, *spasmos*, a spasm), remedies to allay spasm of pain, flatulence, &c., p. 897.

Anus (Lat. *anus*, the sitting thing), the termination of the bowel, p. 130.

Aorta (Gr. *aeirō*, I take up or carry), the large artery springing from the left side of the heart, p. 219.

Aperients (Lat. *aperio*, I open), medicines which gently open the bowels, p. 856.

Aphasia (Gr. *a*, not, and *phēmi*, I speak), a disease of the brain causing loss of the faculty of speech, p. 94.

Aphemia (Gr. *a*, not, and *phēmi*, I speak), loss of faculty of speech, p. 120.

Aphonia (Gr. *a*, not, *phōnē*, the voice), loss of voice, p. 287.

Aphthæ (Gr. *aphtha*, from *aptō*, I set on fire), the patches of thrush, p. 149.

Apnœa (Gr. *a*, not, *pneō*, I breathe), temporary arrest of breathing through saturation of the blood with oxygen, p. 286.

Aponeuroses, fibrous membranes inclosing muscles, p. 73.

Arachnoid (Gr. *arachnē*, a spider's web, and *eidos*, shape), a membrane of brain and spinal cord, pp. 91, 97.

Argyria (Gr. *arguros*, silver), discoloration of the skin due to prolonged use of silver as an internal remedy.

Arthritis (Gr. *arthron*, a joint), inflammation of a joint, p. 33.

Articulation (Lat. *articulus*, a joint), a joint, p. 23.

Arytenoid (Gr. *arutaina*, a pitcher), cartilages of the box of the windpipe, p. 262.

Ascaris (Lat. *ascaris*, a worm), a round-worm, p. 173.

Ascites (Gr. *askitēs*, from *askos*, a bag), dropsy of the belly, p. 191.

Asphyxia (Gr. *asphuxia*, a stopping of the pulse), suffocation, pp. 285, 1008.

Asthenopia (Gr. *a*, not, *sthenos*, strength, *ōps*, the eye), weak-sightedness, p. 378.

Astigmatism (Gr. *a*, want of, and *stigma*, a point), a defect of the eye, causing blurred vision, p. 378.

Astragalus (Gr. *astragalos*), the bone of the ankle on which the lower leg bones rest, p. 23.

Atavism (Lat. *atavus*, a grandfather), the inheritance of some peculiarity existing in a grandparent, but absent from the parent, p. 7.

Atelectasis (Gr. *atelēs*, imperfect, and *ektasis*, widening), imperfect expansion of the lungs after birth, p. 283.

Atheroma (Gr. *athara*, gruel), a disease of arteries, p. 244.

Atonic (Gr. *a*, not, and *tonos*, tone), without tone or power.

Auditory (Lat. *audio*, I hear), belonging to the organ or sense of hearing, p. 357.

Auricle (Lat. *auricula*, a little ear), the upper chamber of each side of the heart, p. 219. The outer part of the ear, p. 356.

Auscultation (Lat. *ausculto*, I listen), a method of examining the body by listening over various parts, p. 266.

Axilla (Lat.), the arm-pit, p. 227.

B.

Bacillus (Lat. *bacillum*, a little rod), a variety of germ, pp. 387, 393.

Bacteria (Gr. *baktērion*, a little staff), a variety of germ, p. 386.

Basilic (Gr. *basilikos*, royal), applied to veins of the arm from the notion that they were of great importance to the body, p. 229.

Biceps (Lat. *bis*, twice, and *caput*, the head), applied to muscles, p. 72.

Bicuspid Teeth (Lat. *bis*, twice, and *cuspis*, a point), applied to teeth, pp. 136, 137.

Bleb (Saxon *blædr*, from *blasan*, to blow), a watery sac or vesicle, p. 313.

Blepharitis (Gr. *blepharon*, the eyelid, and *itis*, signifying inflammation), inflammation of the edge of the eyelid, p. 367.

Bothriocephalus latus (Gr. *bothrion*, a little pit, and *kephalē*, the head, Lat. *latus*, broad), a tape-worm, pp. 168, 170.

Brachial (Lat. *brachium*, the arm), belonging to the arm, p. 99.

Bromism, symptoms due to continued use of the bromides, p. 905.

Bronchiectasis (Gr. *bronchia*, bronchial tubes, and *ektasis*, widening), dilatation of bronchial tubes, p. 272.

Bronchitis (Gr. *bronchos*, and *itis*, signifying inflammation), inflammation of bronchial tubes, p. 270.

Bronchocele (Gr. *bronchos*, the windpipe, and *kēlē*, tumour), goitre, p. 210.

Bronchus (Gr. *bronchos*), applied to the two divisions of the windpipe, p. 251.

Bubo (Gr. *boubōn*, the groin), an inflammation of a lymphatic gland, usually of the groin, pp. 987, 988.

Bulimia (Gr. *bou*, indicating emphasis, and *limos*), morbid hunger, p. 146.

Bulla (Lat. *bulla*, a bubble of water), a bleb, p. 313.

Bursæ (Gr. *bursa*, a bag or purse), applied to small sacs, secreting fluid, placed over a joint or tendon to facilitate its movement and prevent friction, p. 75.

C.

Cachexia (Gr. *kakos*, bad, and *hexis*, a habit), a morbid condition of body, p. 4.

Cæcum (Lat. *cæcus*, blind), the beginning of the large intestine, p. 130.

Calcaneus (Lat. *calcaneum*, from *calx*, the heel), the bone of the heel, p. 83.

Calcareous (Lat. *calx*, lime), chalky, pp. 243, 923.

Calculus (Lat. *calculus*, a small stone, from *calx*, chalk), applied to any concretion formed in the body, p. 298.

Callus (Lat. *callus*, hardness), the material formed round the ends of a broken bone to knit them together, p. 36.

Calorie (Lat. *calor*, heat), the unit of heat, p. 529.

Calorimeter (Lat. *calor*, heat, and Gr. *metron*, a measure), an instrument for measuring amount of heat given off from a body.

Canaliculi (Lat. *canaliculus*, a small channel), small canals in bone, p. 18.

Cancellated (Lat. *cancelli*, lattice), applied to spongy bone because of the lattice-like arrangement of the bone spicules, p. 17.

Canities (Lat. *canities*, hoariness, from *canus*, gray-haired), grayness of hair, p. 329.

Capelline (from Lat. *caput*, the head), applied to a bandage for the head, p. 960.

Capillaries (Lat. *capillus*, a hair), the finest subdivisions of the blood-vessels, p. 225.

Carbo-hydrates (Lat. *carbo*, a coal, and Gr. *hudōr*, water), compounds of carbon with hydrogen and oxygen in proportions to form water, such as sugar and starches, p. 133.

Carbonaceous (Lat. *carbo*), of the nature of carbon, applied to sugary and starchy food-stuffs, p. 538.

Carcinoma (Gr. *karkinos*, a crab), a variety of cancer, p. 433.

Cardiac (Gr. *kardia*, the heart), belonging to the heart.

Caries (Lat. *caries*, rottenness), ulceration of bone, p. 26.

Carminatives (Lat. *carmen*, a song or charm), applied to remedies for flatulence, p. 848.

Carotid (from Gr. *karoō*, to throw into a heavy sleep), applied to the large arteries of the neck by the ancients from belief that they were the cause of deep sleep.

Carpus (Gr. *karpos*, the wrist), the wrist, p. 22.

Cartilage (Lat. *cartilago*), gristle, p. 23.

Casein (Lat. *caseus*, cheese), an albuminous body, the chief component of curd of milk, p. 132.

Caseous (Lat. *caseus*, cheese), cheesy. Frequently applied to morbid stuff found in inflamed glands.

Catalepsy (Gr. *katalambanō*, to attack), a disease in which sensation and consciousness are suspended and the body is rigid, p. 521.

Cataract (Gr. *katarassō*, I fall down), an affection of the lens of the eye causing blindness, p. 374.

Catarrh (Gr. *kata*, down, *reō*, I flow), inflammation of a mucous membrane attended by discharge, for example, cold in the head, p. 154.

Cathartic (Gr. *kathairō*, I purge), a variety of purgative medicines, p. 860.

Catheter (Gr. *kathetēr*, anything let down into), an instrument passed into the bladder to draw off water, p. 1050.

Cauda equina (Lat. *cauda*, a tail, *equinus*, belonging to a horse), the bundle of nerves passing off from the end of the spinal marrow, p. 97.

Cellular (Lat. *cellula*, a little cell), consisting of cells or cavities, p. 16.

Cellulose (deriv. same as above), a variety of starch, p. 537.

Cephalalgia (Gr. *kephalē*, the head, and *algos*, pain), pain in the head.

Cephalic (Gr. *kephalikos*, belonging to the head), applied to veins of the arm, p. 229.

Cerebellum (diminutive of Lat. *cerebrum*, the brain), the hind brain, p. 90.

Cerebritis (*cerebrum*, and terminal *itis*), inflammation of the brain, p. 101.

Cerebro-spinal (*cerebrum*, and *spina*, the spine), related to both brain and spinal cord, p. 89.

Cerebrum (Lat. *cerebrum*, the brain), the large brain, p. 89.

Cerumen (Lat. *cera*, wax), ear-wax, p. 356.

Cervical (Lat. *cervix*, the neck), related to the neck, p. 20.

Cestodes (Gr. *kestos*, a studded girdle, and *eidos*, likeness), tapeworms.

Chalazion (Gr. *chalaza*, hail), a tumour of eyelid, p. 368.

Chalybeate (Gr. *chalups*, iron), containing iron, as chalybeate waters, p. 947.

Chloasma (Gr. *chloaxō*, to be green), an affection of the skin, p. 322.

Chlorosis (Gr. *chlōros*, green), green-sickness, p. 235.

Chologogue (Gr. *chōlē*, bile, and *agō*, I lead out), remedies which induce a flow of bile, p. 856.

Chorea (Gr. *choreia*, a dancing), St. Vitus' dance, p. 125.

Chronic (Gr. *kronikos*, concerning time), applied to long-standing disease, p. 4.

Chyle (Gr. *chulos*, juice), nutritive fluid absorbed from the bowel, p. 200.

Chyluria (*chyle*, and Gr. *ouron*, urine), chyle in the urine, p. 305.

Chyme (Gr. *chumos*, juice), the partially digested material which passes into the bowel from the stomach, p. 129.

Cicatrix (Lat. *cicatrix*, a scar), the scar of a healed wound, p. 968.

Cilium (plural *cilia*, Lat. *cilium*, an eyelash), applied to minute hair-like processes on cells, p. 16.

Cirrhosis (Gr. *kirros*, yellow), originally applied to a disease of the liver, now applied to thickening of connective tissue of any organ, p. 196.

Clavicle (Lat. *clavicula*, a little key), the collar-bone, p. 21.

Clonic (Gr. *klonos*, commotion), of an irregular movement, jerking.

Clysters (Gr. *kluzō*, I wash away), an injection into the bowel, p. 873.

Coccyx (Gr. *kokkux*, the cuckoo), the four rudimentary bones united together and forming the end of the backbone in man; called *os coccygis*, or bone of the cuckoo, from a supposed resemblance to the bill of the cuckoo, p. 20.

Cœliac (Gr. *koilia*, the belly), belonging to the belly.

Colloid (Gr. *kolla*, glue), a term applied by Graham to insoluble non-crystalline organic substances which cannot pass through organic membranes, such as starch, p. 134.

Colon (Gr. *kolon*, food), part of the large bowel, p. 130.

Colostrum (Lat. *colostrum*), the first milk in the breasts after delivery.

Columnæ carneæ (Lat., meaning fleshy pillars), applied to muscular projections on inner wall of heart, p. 222.

Coma (Gr. *kōma*, deep sleep), deep sleep of an unnatural kind, the person being incapable of being roused to consciousness, p. 102.

Comedones (Lat. *comedo*, a glutton), the black-pointed mattery substance that can be squeezed out of the hair-sacs of cheeks, forehead, and nose, p. 327.

Commissure (Lat. *committo*, I join together), a bond of connection.

Condyle (Gr. *kondulos*, a hard knob), a prominent part of a bone in connection with a joint, p. 23.

Congenital (Lat. *con*, together, and *genitus*, begotten), applied to any disease or malformation, &c., existing at birth, p. 3.

Conjunctiva (Lat. *con*, together, and *jungo*, I join), the membrane which lines the inner surface of the eyelids and is reflected on to the eyeball, p. 339.

Conjunctivitis (Lat. *conjunctiva*, and terminal *itis*), inflammation of the conjunctiva, p. 368.

Contagion (Lat. *con*, together, *tango*, I touch), the communication of disease by the transference from the diseased person to another of the special seed or germ of the disease by contact direct or indirect, p. 384.

Contusion (Lat. *con*, together, and *tundo*, I beat), a bruise, p. 974.

Convalescence (Lat. *convalesco*, to grow well), the stage of recovery from illness.

Coracoid (Gr. *korax*, a raven, and *eidos*, likeness), applied to a process of the shoulder-blade, from a supposed resemblance to a crow's beak.

Corium (Lat. *corium*, the skin), the true skin, p. 307.

Cornea (Lat. *cornu*, a horn), the transparent part of the front of the eyeball, p. 339.

Coronary (Lat. *corona*, a crown), applied to vessels that encircle parts. Coronary vessels of heart, p. 219.

Coronoid (Gr. *korōne*, a crow, and *eidos*, likeness), applied to processes of lower jaw (p. 22) and lower end of upper arm-bone.

Corpora Quadrigemina (Lat. *corpus*, a body, and *quadrigeminus*, fourfold), ganglia at base of brain, p. 90.

Corpora Striata (Lat. for striated bodies), ganglia at base of brain, p. 90.

Corpus Callosum (Lat. for thick-skinned body), a transverse mass of nervous substance connecting the two hemispheres of the brain, p. 89.

Corpuscle (Lat. *corpusculum*, diminutive of *corpus*, a body), small cellular bodies, as the cells of the blood, p. 213.

Coryza (from Gr. *korus*, the head), cold in the head, p. 154.

Costal (Lat. *costa*, a rib), related to the ribs, p. 256.

Cranium (Gr. *kranion*, the skull), the skull; that part of the head distinguished from the face, p. 19.

Crepitation (Lat. *crepitus*, a crackling), the feeling of grating of the two ends of a broken bone, p. 40. It is applied also to the sound heard in the lungs on listening over the chest when material is present in the lungs, as in inflammation.

Cribriform (Lat. *cribrum*, a sieve, and *forma*, shape), applied to a part of the ethmoid bone, p. 19.

Cricoid (Gr. *krikos*, a ring, and *eidos*, likeness), applied to a part of the box of the windpipe, p. 250.

Crural (Lat. *crus*, the leg), belonging to the leg, p. 192.

Cuneiform (Lat. *cuneus*, a wedge), a bone of the wrist, pp. 22, 23.

Cuticle (Lat. *cuticulus*, diminutive of *cutis*, the skin), the scarf-skin, p. 307.

Cyanosis (Gr. *kuanōsis*, a dark-blue colour), lividity, p. 244.

Cyst (Gr. *kustis*, the bladder), a sac filled with more or less fluid contents.

Cysticercus (Gr. *kustis*, the bladder, and *kerkos*, a tail), the bladder-worm, a stage in the development of tape-worm, p. 169.

Cystitis (*cyst*, and termination *itis*), inflammation of the urinary bladder, p. 305.

D.

Deglutition (Lat. *deglutio*, I swallow down), the act of swallowing, p. 143.

Dementia (Lat. *de*, negative, and *mens*, the mind), a species of insanity, p. 109.

Dental (Lat. *dens*, a tooth), belonging to a tooth, p. 137.

Dermis (Gr. *derma*, the skin), the true skin, p. 307.

Desquamation (Lat. *desquamo*, I scale off, from *de*, away, and *squama*, a scale), a scaling or peeling of the scarf-skin, p. 313.

Diabetes (Gr. *dia*, through, and *bainō*, I go on), a disease in which a large quantity of urine containing sugar is passed, p. 147.

Diagnosis (Gr. *dia*, between, and *gnōsis*, knowledge), the determining a disease by means of the observation of symptoms, &c., p. 8.

Diaphoretics (Gr. *diaphoreō*, to carry across), drugs which increase the amount of sweat, p. 887.

Diaphragm (Gr. *diaphragma*, a partition), the tendinous and muscular partition between chest and belly, p. 253.

Diarrhœa (Gr. *dia*, through, and *reō*, I run), the disease characterized by very frequent fluid motions, p. 184.

Diastase (Gr. *diastasis*), a ferment formed in grain during germination, p. 666.

Diastasis (Gr. *diastasis*, a separation), applied to the separation of the ends from the shaft of growing bone, p. 35.

Diastole (Gr. *diastellō*, I open) applied to the dilatation of the cavities of the heart, p. 224.

Diathesis (Gr. *diathesis*, a placing in order, a state or condition), a condition of body rendering it liable to certain special diseases; for example, a gouty diathesis, p. 7.

Digastric (Gr. *dis*, double, and *gastēr*, the belly), two-bellied; applied to a muscle, p. 70.

Digit (Lat. *digitus*, a finger), a finger or toe. *Digital*, belonging to fingers or toes.

Diploë (Gr. *diploē*, a fold), the spongy bone between the outer and inner tables of bone making the thickness of the skull bone.

Diplopia (Gr. *diploos*, double, and *opsis*, sight), double sight, seeing double, p. 379.

Dipolar (Gr. *dis*, double, and *polos*, the axis of a globe), two-poled; applied to nerve-cells, p. 85.

Dipsomania (Gr. *dipsa*, thirst, and *mania*, madness), the unconquerable craving for drink, p. 105.

Disinfection (Lat. *dis*, negative, and *inficio*, I corrupt), the destruction of infective material, p. 395.

Diuretics (Gr. *dia*, through, and *oureō*, I pass water), drugs which increase the flow of urine, p. 890.

Dorsal (Lat. *dorsum*, the back), belonging to the back, pp. 20, 99.

Drastic (Gr. *drastikos*, active, from *draō*, I do), applied to vigorous purgative medicines, p. 861.

Duodenum (Lat. *duodeni*, twelve apiece), the first part of the small intestine, about 12 inches long.

Dura Mater (Lat., meaning hard mother), applied to the external membrane investing brain and spinal cord; old idea being that it gave origin to all other membranes of the body, and it is of tough quality, p. 91.

Dysmenorrhœa (Gr. *dus*, difficulty, *mēn*, a month, and *reō*, I flow), painful monthly illness, p. 510.

Dyspareunia (Gr. *duspareunos*, ill-mated), difficult or painful performance of the sexual function, p. 519.

Dysphagia (Gr. *dus*, and *phagein*, to eat), difficulty of swallowing, p. 157.

Dysphonia (Gr. *dus*, and *phonē*, the voice), imperfect voice, p. 287.

Dyspnœa (Gr. *dus*, and *pneō*, I breathe), difficulty of breathing, p. 284.

E.

Ecchymosis (Gr. *ek*, out, and *cheō*, I pour), an effusion of blood into the skin or tissue beneath it, producing the well-known discoloration of a bruise, p. 974.

Ectropion (Gr. *ektrepō*, to divert), applied to the turning outwards of the inner surface of the eyelid, p. 367.

Eczema (Gr. *ekzema*, something thrown out by heat, from *ekzeō*, I boil over), a skin disease, p. 318.

Efferent (Lat. *e* or *ex*, out, and *fero*, I carry), outgoing; applied to vessels or nerves carrying material or impressions from the centre to the circumference of the body, p. 87.

Effleurage (French, *effleurer*, to touch lightly), a variety of stroke in massage, p. 772.

Efflorescence (Lat. *effloresco*, I flourish), a flowering; applied in medicine to the rash of fevers.

Embolism (Gr. *emballō*, I throw in), applied to the obstruction of a blood-vessel by something carried to it in the blood stream. The obstructing thing is called an *embolus*, p. 102.

Embrocation (Gr. *embrechō*, I soak in), a fluid for external application to a part.

Embryo (Gr. *embruon*, from *em*, in, and *bruō*, I swell with), the rudiment of a living thing; applied to the growing offspring before the fourth month of pregnancy, p. 485.

Emetic (Gr. *emeō*, I vomit), applied to substances which induce vomiting, p. 850.

Emphysema (Gr. *emphusēma*, an inflation), applied to an over-distended condition of air-cells of the lungs, p. 271.

Emprosthotonus (Gr. *emprosthen*, forwards, and *teinō*, I stretch), a condition in which, by spasmodic contraction of muscles, the body is bent forwards, p. 126.

Empyema (Gr. *em*, within, and *puon*, pus, matter), a collection of matter in the chest cavity, p. 267.

Emunctory (Lat. *emungo*, I blow the nose), applied to organs or channels by which effete matter is removed from the body.

Encephaloid (Gr. *encephalos*, the brain, *eidos*, likeness), brain-like, p. 434.

Encephalon (Gr. *en*, in, and *kephalē*, the head), the parts within the skull, p. 89.

Endemic (Gr. *en*, in, and *dēmos*, a people), applied to a disease peculiar to a people or neighbourhood from some cause special to it, p. 4.

Endocarditis (Gr. *endon*, within, *kardia*, the heart, and terminal *itis*), inflammation of the inner lining membrane of the heart, p. 239.

Endocardium (same deriv. as above), the inner lining membrane of the heart, p. 220.

Endolymph (Gr. *endon*, within, and Lat. *lympha*, water), applied to fluid in canals of inner ear, p. 358.

Endosmosis (Gr. *endon*, and *ōsmos*, a pushing in), the process by which a substance in solution passes to the inner side of an organic membrane, p. 134.

Endosteum (Gr. *endon*, and *osteon*, a bone), the lining membrane of the marrow cavity of a bone, p. 18.

Endostitis (same deriv. as above, with terminal *itis*), inflammation of endosteum, p. 27.

Enema (Gr. *enema*, from *eniēmi*, to inject), an injection, p. 873.

Enteric (Gr. *enteron*, the bowel), belonging to the bowels. See enteric fever, p. 411.

Enteritis (same deriv. as *enteric*, with terminal *itis*), inflammation of bowel, p. 162.

Entropion (Gr. *en*, in, and *trepō*, I turn), a turning in of the eyelid, p. 367.

Epidemic (Gr. *epi*, upon, *dēmos*, a people), applied to disease prevalent among a people, and due to a special cause not commonly present, p. 4.

Epidermis (Gr. *epi*, upon, and *derma*, the skin), the scarf-skin, p. 307.

Epigastrium (Gr. *epi*, upon, and *gastēr*, the stomach), the region of the belly over the stomach, the epigastric region, p. 131.

Epiglottis (Gr. *epi*, upon, and *glottis*, the upper opening of the windpipe), the structure that acts as a lid to the windpipe, p. 136.

Epiphyses (Gr. *epi*, upon, and *phuō*, I grow), applied to the ends of a long bone, which in development become ossified apart from the shaft, p. 18.

Epispastics (Gr. *epi*, upon, and *spaō*, I draw), remedies which blister, p. 914.

Epistaxis (Gr. *epi*, upon, and *stazō*, I let fall in drops), bleeding from the nostrils, p. 366.

Epithelioma (Gr. *epi*, upon, and *thēlē*, the nipple), skin cancer, p. 434.

Epithelium (Gr. *epi*, upon, and *thēlē*, a nipple), the layer or layers of cells forming the surface layer of skin or mucous membrane, p. 16.

Eructation (Lat. *eructo*, I belch), a belching of wind from the stomach.

Erythema (Gr. *eruthainō*, I make to blush), a slight inflammation, redness of skin, p. 313.

Ethmoid (Gr. *ēthmos*, a sieve, and *eidos*, likeness), a bone of the skull, p. 19.

Exanthemata (Gr. *exanthēma*, an eruption), infectious fevers attended by rash, p. 397.

Excoriation (Lat. *ex*, out of, and *corium*, the skin), an abrasion.

Excreta (Lat. *excerno*, I sift out), effete material removed from the body.

Exophthalmia (Gr. *ex*, out, and *ophthalmos*, the eye), protrusion of the eyeball.

Exostosis (Gr. *ex*, out, and *osteon*, a bone), a bony outgrowth from bone due to disease, p. 27.

Expectorant (Lat. *ex*, out of, and *pectus*, the breast), remedies which promote the expulsion of material from lungs and air-passages, p. 879.

Expectoration (Lat. *ex*, out of, and *pectus*, the breast), spitting out material from mouth, throat, lungs, &c., and also the material so expelled.

Extravasation (Lat. *extra*, outside of, and *vasa*, vessels), the pouring out among the tissues from a cavity or vessel of its fluid contents, p. 974.

Exudation (Lat. *ex*, out, and *sudo*, I sweat), oozing of fluid through the walls of the vessel or receptacle which contains it; also the material which exudes, p. 248.

F.

Fæces (Lat. *fæx*, sediment), motions from the bowel.

Farinaceous (Lat. *farina*, flour), applied to starchy food-stuffs, p. 584.

Fascia (Lat. *fascia*, a band), applied to the fibrous tissue investing muscles, &c., p. 67.

Fauces (Lat. for the upper part of the throat), the cavity at the back of the mouth, p. 136.

Febrifuge (Lat. *febris*, fever, and *fugo*, I drive away), applied to remedies for fever, p. 820.

Femoral (Lat. *femur*, the thigh), belonging to the thigh, p. 228.

Femur (Lat. for the thigh), the thigh-bone, p. 23.

Fibula (Lat. *fibula*, a brooch), the clasp-bone, the outer bone of the foreleg, p. 23.

Fission (Lat. *fissio*, a dividing), the process of cleavage in cell reproduction, p. 387.

Fistula (Lat. *fistula*, a tube), an unnatural channel leading from the outside of the body inwards, p. 500.

Flatulence (Lat. *flatus*, a breath), wind in stomach or bowels.

Fluctuation (Lat. *fluctus*, a wave), the wave-like feeling communicated to the fingers when a cavity containing fluid is smartly tapped, p. 32.

Fœtus (Lat. *fœtus*, offspring), applied to the child in the womb in the later months, p. 485.

Furunculus (Lat.), a boil, p. 365.

G.

Ganglion, pl. **Ganglia** (Gr. *ganglion*, a tumour under the skin), an enlargement in the course of a nerve, containing nerve-cells as well as nerve-fibres, pp. 78, 85.

Gangrene (Gr. *grainō*, I gnaw), death of tissue in mass, p. 248.

Gastralgia (Gr. *gastēr*, stomach, and *algos*, pain), pain at the region of the stomach. Same as gastrodynia.

Gastric (Gr. *gastēr*, the stomach), related to the stomach.

Gastritis (Gr. *gastēr*, and terminal *itis*), inflammation of the stomach, p. 157.

Gastrocnemius (Gr. *gastēr*, the belly, and *knēmē*, the leg), the muscle of the calf of the leg, p. 74.

Gastrodynia (Gr. *gastēr*, and *odunē*, pain), pain in the stomach, p. 181.

Gastro-enteritis (Gr. *gastēr*, and *enteron*, the bowel), inflammation of both stomach and bowel.

Genu-valgum (Gr. *gonu*, the knee, and Lat. *valgus*, having the legs bent outwards), knock-knee, p. 83.

Gland (Lat. *glans*, an acorn), an organ for manufacturing some material for the blood for subsequent use in the body or for removal from the body, or which takes part in blood formation, p. 201, 204.

Glaucoma (Gr. *glaukos*, denoting a greenish-yellow colour), a disease of the eye causing blindness, p. 375.

Glenoid (Gr. *glēnē*, the pupil or eyeball, and *eidos*, likeness), applied to a depression in one bone to receive the head of another, p. 21.

Glomerulus (Lat., diminutive of *glomus*, a small ball), applied to the tufted arrangement of vessels in the kidney, p. 290.

Glosso-pharyngeal (Gr. *glossa*, the tongue, and *pharunx*, the throat), connected with tongue and throat, applied to one of the cranial nerves, p. 90.

Glottis (Gr. *glottis*, the upper opening of the windpipe), the opening in the box of the windpipe between the vocal cords, p. 262.

Gluteus (Gr. *gloutos*, the buttock), belonging to the buttock; applied to muscles, nerves, and vessels, p. 73.

Glycogen (Gr. *glukus*, sweet, and *gennaō*, I produce), animal starch, p. 147.

Glycosuria (Gr. *glukus*, sweet, and *ouron*, urine), sugar in urine, p. 303.

Granulation (Lat. *granum*, a grain), applied to the small bright grain-like fleshy elevations that appear on a healing wound; also to the process by which open wounds heal.

Gumma, pl. **Gummata** (Lat. *gumma*, gum), small tumours that occur in various tissues as a consequence of syphilis, p. 424.

Gustatory (Lat. *gusto*, I taste), relating to taste, as gustatory nerve, the nerve of taste, p. 337.

H.

Hæmatemesis (Gr. *haima*, blood, and *emeō*, I vomit), vomiting of blood, p. 159.

Hæmatinuria (Gr. *hæmatin*, the colouring matter of blood, and *ouron*, urine), passage of urine containing the colouring matter of blood, p. 304.

Hæmaturia (Gr. *haima*, blood, and *ouron*, urine), blood in the urine, p. 304.

Hæmophilia (Gr. *haima*, blood, and *philia*, fondness for), a disposition to bleeding, p. 238.

Hæmoptysis (Gr. *haima*, and *ptusis*, spitting), blood-spitting, the blood being from the lungs, p. 282.

Hæmorrhage (Gr. *haima*, and *rēgnumi*, I break forth), escape of blood from the vessels.

Hæmorrhoids (Gr. *haima*, and *reō*, I flow), piles, p. 193.

Hemeralopia (Gr. *hēmera*, the day, and *ōps*, the eye), blindness, except in daylight, p. 378.

Hemiopia (Gr. *hemisus*, half, and *ōps*, the eye), a condition in which only one half of an eye has perception of things.

Hemiplegia (Gr. *hemisus*, half, and *plēgē*, a stroke), paralysis of motion on one side of the body, p. 118.

Hepatic (Gr. *hēpar*, the liver), belonging to the liver.

Hepatitis (Gr. *hēpar*, the liver, and *itis*), inflammation of the liver, p. 196.

Hirsuties (Lat. *hirsutus*, hairy), an unnatural development of hair, p. 329.

Hordeolum (Lat. *hordeolus*, diminutive of *hordeum*, barley), a sty in the eye, p. 368.

Humerus (Lat.), the upper arm bone, p. 21.

Hyaline (Gr. *hualos*, glass), transparent like glass. See hyaline cartilage, p. 24.

Hybernation (Lat. *hibernus*, belonging to winter), the dormant state into which certain animals and plants fall with a low temperature, p. 113.

Hydatid (Gr. *hudatis*, a watery sac), a stage in the development of tape-worm, p. 172.

Hydragogue (Gr. *hudōr*, water, and *agō*, I lead out), remedies which cause a watery discharge from the bowels.

Hydrocele (*hudōr*, and *kēlē*, a tumour), a tumour with watery contents connected with external generative organs.

Hydrocephalus (Gr. *hudōr*, water, and *kephalē*, the head), water in the head, p. 101.

Hydrometer (Gr. *hudōr*, and *metron*, a measure), an instrument for determining specific gravity of watery fluids.

Hydronephrosis (Gr. *hudōr*, and *nephros*, the kidney), dropsy of the kidney, p. 299.

Hydropericardium (Gr. *hudōr*, water, *peri*, about, and *kardia*, the heart), dropsy of the heart, p. 435.

Hydrothorax (Gr. *hudōr*, and *thorax*, the chest), dropsy of the chest.

Hygiene (Gr. *hugieinos*, good for the health), the science of the laws of health, p. 522.

Hygroscopic (Gr. *hugros*, moist, and *skopeō*, I look at), having the property of absorbing moisture.

Hyoid (Gr. *huoeidēs*, shaped like the Greek letter upsilon), applied to the bone at the root of the tongue, p. 250.

Hyperæmia (Gr. *huper*, in excess, and *haima*, blood), an excess of blood in a part, p. 235.

Hyperæsthesia (Gr. *huper*, and *aisthēsis*, a feeling), oversensibility, p. 364.

Hypermetropia (Gr. *huper*, *metron*, a measure, and *ōps*, the eye), longsightedness.

Hypertrophy (Gr. *huper*, and *trophē*, nourishment), overgrowth, p. 76.

Hypnotics (Gr. *hupnos*, sleep), drugs which procure sleep, p. 904.

Hypochondriasis (*hupochondriakos*, one affected in hypochondriac region), a form of melancholy in which the person believes himself to be suffering now from one disease, now from another. The cause of the disease was of old referred to the hypochondriac region.

Hypochondrium (Gr. *hupo*, under, and *chondros*, gristle, under the gristly part of the ribs), the regions of the body on the right and left side below the ribs.

Hypodermic (Gr. *hupo*, under, and *derma*, the skin), put under the skin.

Hypogastric (Gr. *hupo*, and *gastēr*, the stomach), referring to the region below that where the stomach is placed, p. 131.

Hypoglossal (Gr. *hupo*, and *glōssa*, the tongue), beneath the tongue, p. 90.

I.

Ichthyosis (Gr. *ichthus*, fish), fish-skin disease, p. 320.

Icterus (Gr. *ikteros*, jaundice), yellowness of skin due to jaundice, p. 198.

Ileo-cæcal (Gr. *eileō*, I turn about, Lat. *cæcum*, blind), applied to the junction between the ileum, end of the small bowel, and cæcum, head of the large bowel, p. 130.

Ileum (Gr. *eileō*, I turn about), applied to the small bowel from its windings, p. 130.

Iliacus (Lat. *ilia*, the flanks), applied to a muscle in the hollow of the ilium, p. 73.

Ilium (Lat. *ilia*, the flanks), part of the bone of the haunch, p. 22.

Impetigo (Lat. *impetigo*, a scabby eruption of the skin), a pustular disease of the skin, p. 319.

Incisor (Lat. *incido*, I cut), applied to the cutting teeth, p. 136.

Incubation (Lat. *incubo*, to sit on eggs), applied in medicine to the period between the introduction of the germs of a disease into the body and the time of first appearance of its symptoms, during which period the disease is being hatched, p. 397.

Infundibulum (Lat. *infundibulum*, a funnel, from *infundo*, I pour in), applied to the passage from which the air-cells of the lungs open, p. 252.

Infusoria (Lat. *infundo*, I pour in), applied to minute organisms first observed in infusions of organic substances, p. 385.

Inguinal (Lat. *inguen*, the groin), belonging to the groin, p. 192.

Inhibitory (Lat. *inhibitus*, a restraining), applied to the restraining influence of one nervous action over another, p. 233.

Innominate (Lat. *in*, negative, and *nomen*, a name), The unnamed bone, haunch-bone, p. 22.

Inoculation (Lat. *inoculo*, I ingraft), the introduction into the body by a wound of the skin of the poison of some disease, p. 405.

Insalivation (Lat. *in*, in, and *saliva*, the spittle), the process of mixing the food with saliva in the mouth, p. 142.

Insolatio (Lat. *insolo*, I place in the sun), sunstroke, p. 1003.

Insomnia (Lat. *in*, negative, and *somnus*, sleep), sleeplessness, p. 116.

Intercostal (Lat. *inter*, between, and *costa*, a rib), applied to structures between the ribs, p. 255.

Intermittent (Lat. *intermitto*, I leave off for a time), applied to diseases which disappear and return again after a variable time, p. 427.

Interossei (Lat. *inter*, and *os*, a bone), situated between bones. See interossei muscles, p. 73.

Intussusception (Lat. *intus*, within, and *suscipio*, I receive), applied to the passage of a part of the bowel within another part, p. 164.

Inunction (Lat. *inungo*, I anoint), the rubbing of an oily substance into the skin, p. 824.

Invagination (Lat. *in*, in, and *vagina*, a sheath), same as intussusception, p. 165.

Iodism, symptoms produced by the taking of iodine in too large or long-continued doses, p. 1020.

Iridectomy (Gr. *iris*, a rainbow, and *ektemnō*, I cut out), an operation for removing a portion of the coloured ring of the eyeball to improve sight, p. 372.

Iritis (Gr. *iris*, and terminal *itis*), inflammation of the iris of the eye, p. 373.

Ischium (Gr. *ischion*, the seat-bone), the seat-bone, p. 22.

J.

Jejunum (Lat. *jejunus*, empty), applied to a portion of the small bowel, believed to be generally found empty after death, p. 130.

Jugular (Lat. *jugulum*, the throat), belonging to the throat, p. 228.

K.

Keratitis (Gr. *keras*, a horn, and terminal *itis*), inflammation of the cornea of the eye, p. 371.

L.

Lachrymal (Lat. *lachryma*, a tear), relating to tears, such as the tear-gland, p. 339.

Lacteal (Lat. *lac*, milk), applied to vessels because of the milky juice contained, p. 145.

Lactometer (Lat. *lac*, and Gr. *metron*, a measure), an instrument for gauging quality of milk, p. 551.

Lacuna (Lat. *lacuna*, a cavity), cavities in bone occupied by bone cells, p. 18.

Lardaceous (Lat. *lardum*, the fat of bacon), applied to a certain form of tissue degeneration, p. 200.

Laryngismus (Gr. *larungizō*, I vociferate), an affection of the box of the windpipe, so called from the peculiar sound of the cry produced in it, p. 273.

Laryngitis (Gr. *larunx*, the upper part of the windpipe, and *itis*), inflammation of the box of the windpipe, p. 269.

Laryngoscope (*larynx*, and Gr. *skopeō*, I look at), an arrangement of mirrors for viewing the larynx, p. 263.

Laryngotomy (*larynx*, and Gr. *temnō*, I cut), the operation of opening the box of the windpipe from outside, p. 262.

Latissimus (Lat. for "very broad"), applied to a muscle of the back, p. 71.

Laxative (Lat. *laxo*, I loosen), opening medicines, p. 856.

Leucocytes (Gr. *leukos*, white, and *kutos*, a cell), white-cells, p. 213.

Leucocythæmia (Gr. *leukos*, *kutos*, and *haima*, the blood), white-celled blood, p. 235.

Leucorrhæa (Gr. *leukos*, and *roia*, a flow), white discharge from the female genital organs, p. 499.

Leukæmia (Gr. *leukos*, white, and *haima*, the blood), same as leucocythæmia, p. 235.

Lientery (Gr. *leios*, smooth, and *enteron*, the bowel), a species of diarrhœa, p. 185.

Ligament (Lat. *ligo*, a tie), a connecting band, p. 23.

Locomotor ataxia (Lat. *locus*, a place, and *moto*, I move, Gr. *a*, wanting, and *taxis*, order), a nervous disease characterized by unsteadiness of gait, p. 121.

Lumbar (Lat. *lumbi*, the loins), applied to the region of the loins, p. 28.

Lymphadenoma (Lat. *lympha*, water, and Gr. *adēnē*, a gland), a disease affecting lymphatic glands and producing great pallor, p. 210.

Lymphangitis (Lat. *lympha*, Gr. *angeion*, a vessel, and terminal *itis*), inflammation of lymphatic vessels, p. 206.

Lymphoma (same as *Lymphadenoma*).

Lysis (Gr. *luo*, I dissolve), the gradual decline of fever as distinct from crisis, p. 397.

M.

Malar (Lat. *mala*, the cheek-bone, from *mando*, I chew), belonging to the cheek-bone, p. 19.

Malaria (Lat. *malus*, bad, *aer*, air), the atmosphere of fever-producing marshy districts.

Malleolus (Lat. *malleus*, a hammer), projections of the lower leg-bones at the ankle, p. 23.

Masseter muscles (Gr. *massaomai*, I chew), applied to muscle of the jaw, p. 70.

Mastication (same deriv. as *masseter*), the act of chewing, p. 142.

Mastoid (Gr. *mastos*, a nipple, and *eidos*, likeness), applied to a nipple-shaped process of the temporal bone, p. 19.

Maxillary (Lat. *maxilla*, a jaw), belonging to the jaw, p. 19.

Medulla (Lat. *medulla*, marrow, for *medius*, middle), the marrow of bone (p.17), or spinal marrow (p. 96).

Medullitis, inflammation of the medulla, p. 27.

Melæna (Gr. *melas*, black), black motions, due to the presence of blood, p. 166.

Meninges (Gr. *mēninx*, a membrane), applied to membranes of brain, p. 91.

Meningitis, inflammation of membranes of brain, p. 100.

Menorrhagia Gr. *mēn*, a month, and *rēgnumi*, I burst forth), excessive monthly flow, p. 509.

Menses (Lat. *mensis*, a month), the monthly discharge, p. 481.

Menstruation (Gr. *mēn*, a month, and *reō*, I flow), the process of the monthly illness, p. 481.

Mesentery (Gr. *mesos*, middle, and *enteron*, intestine), a membrane connected with the intestine, pp. 131, 191. *Mesenteric*, belonging to the mesentery.

Metacarpal (Gr. *meta*, beyond, and *carpus*, the wrist), applied to the bones between the wrist and finger bones, the bones of the palm, p. 22.

Metatarsal (Gr. *meta*, beyond, and *tarsos*, the instep), applied to the bones between ankle and toes, p. 23.

Metrorrhagia (Gr. *mētra*, the womb, and *rēgnumi*, I burst forth), a discharge of blood from the womb at other than the monthly periods, p. 509.

Microbe (Gr. *micros*, small, and *bios*, life), same as micro-organism.

Micro-coccus (Gr. *mikros*, and *kokkos*, a berry), a form of germ, p. 387.

Micro-organisms (Gr. *mikros*), small living organisms, p. 387.

Microphytes (Gr. *mikros*, small, and *phutos*, a plant), the same meaning as micro-organisms, p. 387.

Microzymes (Gr. *mikros*, and *zumē*, yeast), applied to minute organisms, because they cause fermentation, p. 387.

Molars (Lat. *mola*, a mill), grinding teeth, p. 136.

Monomania (Gr. *monos*, single, and *mania*, madness), that form of insanity in which the aberration is in regard to one subject only, p. 108.

Morphinomania (*morphia* and *mania*), the craving for morphia, p. 1026.

Multipolar (Lat. *multus*, many, and *polos*, an axis), applied to cells with many processes, p. 85.

Myelitis (Gr. *muelos*, marrow, and terminal *itis*, inflammation), inflammation of the spinal cord, p. 117.

Myopia (Gr. *muō*, I shut or blink, and *ōps*, the eye), short-sightedness, p. 347.

N.

Nævus (Lat. *nævus*, a spot), a mother's mark, p. 247.

Narcotics (Gr. *narka*, deep sleep), p. 904.

Nausea (Gr. *nausia*, sickness, from *naus*, a ship, in relation to sea-sickness), a feeling of sickness, p. 12.

Necrosis (Gr. *nekros*, dead), death of bone, p. 26.

Nematode (Gr. *nema*, a thread, and *eidos*, likeness), a round-worm, p. 167.

Nephritis (Gr. *nephros*, the kidney, and *itis*), inflammation of the kidney, p. 295.

Neurilemma (Gr. *neuron*, a nerve, and *lemma*, a skin), the connective tissue investment of nerve-fibres, p. 85.

Neuritis (Gr. *neuron*, and *itis*), inflammation of a nerve.

Neuroglia (Gr. *neuron*, a nerve, and *glia*, glue), the connective tissue ground-substance of nervous tissue, p. 91.

Neuroma (Gr. *neuron*, a nerve), a nerve tumour.

Neurosis (deriv. as above), a nervous affection without discoverable structural change or material cause. A functional disorder.

Nyctalopia (Gr. *nux*, night, *alaos*, blind, and *ōps*, the eye), night blindness.

Nystagmus (Gr. *nustazō*, I nod), an involuntarily rolling motion of the eye-ball, p. 376.

O.

Obturator (Lat. *obturo*, to stop up), applied to an opening in the pelvis, and to muscles, vessels, and nerves passing through it.

Occipital (Lat. *occiput*, the back of the head), p. 19.

Odontoid (Gr. *odous*, a tooth, and *eidos*, likeness), applied to a process of the second cervical vertebra, p. 21.

Œdema (Gr. *oideō*, I swell), dropsy of the cellular tissue, p. 435.

Œsophagus (Gr. *oisō*, I bear, and *phagein*, to eat), the gullet, p. 157.

Olecranon (Gr. *ōlenē*, the ulna, and *kranon*, head), applied to a process of the head of the ulna, one of the fore-arm bones, p. 22.

Olfactory (Lat. *oleo*, I smell, and *facio*, I make), related to the sense of smell, p. 90.

Onychia (Gr. *onux*, the nail), inflammation of the nail, p. 330.

Ophthalmia (Gr. *ophthalmos*, the eye), applied to certain inflammations of the eye, p. 368.

Ophthalmoscope (Gr. *ophthalmos*, the eye, and *skopeō*, I view), an instrument for examining the interior of the eye, p. 376.

Opiate (Gr. *opion*, from *opos*, a vegetable juice), a drug containing opium, or one which induces sleep, p. 897.

Opisthotonus (Gr. *opisthen*, backwards, and *teinō*, I draw), a state of spasm in which the body is bent backwards like a bow, pp. 126, 1028.

Os calcis (Lat. for the bone of the heel, *calx*, the heel), p. 23.

Os coccyx (Lat. for the coccyx bone). See Coccyx.

Os magnum (Lat. for large bone), a bone of the wrist, p. 22.

Os sacrum (Lat. for sacred bone, because it was formerly offered in sacrifice), a part of the backbone, p. 22.

Ossification (Lat. *os*, a bone, and *facio*, I make), the process of bone formation, p. 18.

Osteomalachia (Gr. *osteon*, a bone, *malakos*, soft), softening of bone, p. 31.

Osteomyelitis (Gr. *osteon*, a bone, and *muelos*, marrow), inflammation of the marrow of bone, p. 25.

Ostitis (Gr. *osteon*, a bone, and *itis*, signifying inflammation), inflammation of bone, p. 25.

Otitis (Gr. *ous*, the ear, and *itis*), inflammation of the ear.

Otoliths (Gr. *ous*, the ear, and *lithos*, a stone), small bony bodies found in the inner ear of some animals, p. 358.

Oxidation (Gr. *oxus*, acid), the process of uniting with oxygen, p. 527.

Oxyuris (Gr. *oxus*, sharp, and *ouron*, a tail), applied to a genus of thread-worms, p. 174.

Ozæna (Gr. *ozē*, a foul smell), stink-nose, p. 365.

P.

Paræsthesia (Gr. *para*, implying irregularity, and *aisthēsis*, sensation), a disorder of sensation. See p. 364.

Paraplegia (Gr. *para*, incompletely, and *plēssō*, I strike), paralysis of the lower limbs, p. 119.

Paresis (Gr. *pariēmi*, I relax), a slight degree of paralysis, p. 118.

Parietal (Lat. *paries*, a wall), applied to bones situated on the side of the head, p. 19.

Parotid (Gr. *para*, near, and *ous*, the ear), applied to a salivary gland in the neighbourhood of the ear, p. 137.

Parotitis, inflammation of the parotid gland—mumps, p. 153.

Patella (Lat. *patella*, a dish), the knee-pan, p. 23.

Pathology (Gr. *pathos*, suffering, and *logos*, discourse), the science which treats of the nature, cause, &c., of disease, p. 54.

Pectoralis (Lat. *pectus*, the breast), related to the breast, p. 71.

Pediculus (Lat. diminutive of *pedis*, a louse), a louse, p. 324.

Pelvis (Lat. *pelvis*, a basin), the cavity formed by the haunch-bones, p. 20.

Pemphigus (Gr. *pemphix*, a bladder), a disease of the skin, p. 317.

Percussion (Lat. *percutio*, I strike), a method of examining the body by striking with the finger or an instrument made for the purpose, to note the kind of sound elicited, p. 266.

Pericarditis, inflammation of pericardium, p. 238.

Pericardium (Gr. *peri*, about, and *kardia*, heart), the membranous investment of the heart, p. 219.

Perilymph Gr. *peri*, around, and *lympha*, water), the fluid within the bony labyrinth of the inner ear, p. 358.

Perinæum (Gr. *peri*, about, and *naiō*, to be situated), the part of the body between the genital organs in front and the opening of the bowel behind.

Periosteum (Gr. *peri*, about, and *osteon*, a bone), the outer lining membrane of bone, p. 17.

Periostitis, inflammation of periosteum, p. 25.

Peristaltic (Gr. *peristellō*, I involve), applied to the vermicular or worm-like movement of the bowel, p. 183.

Peritoneum (Gr. *peri*, about, *teinō*, I stretch), the delicate membrane investing the inner surface of the abdomen, p. 130.

Peritonitis, inflammation of peritoneum, p. 190.

Perityphlitis (Gr. *peri*, around, and *tuphlon*, the head of the large bowel), inflammation of the connective tissue around the cæcum—the head of the large bowel, p. 163.

Pertussis (Lat. *per*, signifying excess, and *tussis*, a cough), whooping-cough.

Petechiæ (Italian, *petecchies*, flea-bites), small purple spots on the skin like flea-bites, p. 237, 240, 427.

Petrissage (French, meaning kneading), a term used in massage, p. 772.

Phalanges (plural of *phalanx*, Greek for a line of soldiers), applied to the bones of fingers and toes.

Pharynx (Gr.), the cavity at the upper end of the gullet, into which the mouth opens, p. 138.

Phlebitis (Gr. *phleps*, a vein, and *itis*), inflammation of veins, p. 246.

Phlyctenæ (Gr. *phluxein*, to be hot), applied to small vesicles on the eyeball, p. 369.

Phrenic (Gr. *phrēn*, the diaphragm), applied to the nerve and vessels of the diaphragm, p. 99.

Phthiriasis (Gr. *phtheir*, a louse), lousiness, p. 324.

Phthisis (Gr. *phthinomai*, I waste), consumption, p. 277.

Physiology (Gr. *phusis*, nature, and *logos*, a discourse), the science which treats of the functions of living things, p. 15.

Pisiform (Lat. *pisum*, a pea, and *forma*, shape), a bone of the wrist, p. 22.

Pityriasis (Gr. *pituron*, bran), a skin disease, accompanied by scurfiness, p. 319.

Plethora (Gr. *plēthō*, I fill), full-bloodedness, p. 235.

Pleura (Gr. *pleuron*, a rib), the membrane lining the inner surface of the chest walls and investing the lungs, p. 253.

Pleurisy, inflammation of the pleura, p. 266.

Pleuritis, same as pleurisy.

Pleuro-pneumonia (Gr. *pleura*, a rib, and *pneumōn*, the lung), an associated inflammation of lungs and pleura, p. 275.

Plexus (Lat., meaning a network), applied to a network of vessels or nerves, p. 99.

Pneumogastric (Gr. *pneumōn*, a lung, and *gastēr*, the belly), a nerve arising within the brain, and distributed to lungs, heart, stomach, &c., p. 96.

Pneumonia (Gr. *pneumōn*, the lung), inflammation of the lung), p. 274.

Pneumothorax (Gr. *pneuma*, air, *thōrax*, the chest), a collection of gas in the chest cavity, p. 269.

Podagra (Gr. *pous*, the foot, and *agra*, a seizure), gout, p. 432.

Polypus (Gr. *polus*, many, and *pous*, a foot), a variety of growth springing from a mucous membrane, p. 381.

Polyuria (Gr. *polus*, much, *ouron*, urine), applied to disease characterized by excess of urine, p. 302.

Pons Varolii (Lat. *pons*, a bridge, and *Varolius*, the name of an anatomist), a transverse mass of fibres connected with the cerebellum, p. 90.

Popliteal (Lat. *poples*, the ham), pertaining to the ham, p. 228.

Presbyopia (Gr. *presbus*, an old man, and *ōps*, the eye), impairment of power of accommodating the eye for near objects, common to age, p. 378.

Prognosis (Gr. *pro*, *gnōsis*, a knowing), the opinion as to the future course of a disease from a consideration of its nature, symptoms, &c., p. 13.

Prolapse (Lat. *pro*, forwards, and *lapsus*, a falling), a variety of displacement of an organ, p. 194.

Pronation (Lat. *pronus*, with face downward), the motion which turns the palm of the hand downward, p. 22.

Prophylactic (Gr. *pro*, before, and *phulassō*, I guard), employed in connection with the prevention of disease, p. 14.

Proteids (Gr. *prōtos*, first), applied to albuminous food-stuffs, p. 132.

Protoplasm (Gr. *prōtos*, first, and *plasma*, formed material), applied to the simplest form of living material, p. 15.

Pruritis (Lat., meaning an itching), a variety of perverted sensation, characterized by itching, pp. 323, 497.

Psoas (Gr. *psoa*), belonging to the loin, as psoas muscle, p, 73.

Psoriasis (Gr. *psoō*, I rub), a scaly disease of the skin, p. 877.

Pterygoid (Gr. *pterux*, a wing, and *eidos*, likeness), applied to bones of the head, and muscles connected with them, p. 70.

Ptomaines (Gr. *ptōma*, a dead body), active principles of the nature of alkaloids—derived from bodies in a state of decay, pp. 599, 1014.

Ptosis (Gr. *ptōsis*, a fall), a drooping of the eyelid, p. 369.

Ptyalism (Gr. *ptualon*, saliva), excessive secretion of saliva, p. 150.

Pubis (Lat. *pubis*, puberty), the front portion of the haunch-bone.

Puerperal (Lat. *puerpera*, a lying-in woman, from *puer*, a boy, and *pario*, I bear), pertaining to childbirth, p. 837.

Pulmonary (Lat. *pulmo*, a lung), belonging to the lung, p. 230.

Purgatives (Lat. *purgo*, I cleanse, and *ago*, I act), remedies which freely act upon the bowels, p. 855.

Purpura (Lat., meaning purple), a disease in which effusions of blood take place into the skin, p. 237.

Pus (Gr. *puon*, matter), matter produced in inflammation, p. 968.

Pyæmia (Gr. *puon*, pus, and *haima*, the blood), a condition of blood-poisoning, p. 236.

Pyelitis (Gr. *puelos*, a vessel, *itis*), an inflammation of a part of the kidney, p. 298.

Pylorus (Gr. *pulōros*, a gatekeeper), the part of the stomach where junction is made with the intestine, p. 130.

Pyrosis (Gr. *puroō*, I burn), waterbrash, p. 181.

Q.

Quartan (Lat. *quartus*, the fourth), a form of ague in which the attack returns after an intermission of two days, p. 428.

Quotidian (Lat. *quotidie*, daily), a form of ague in which the attack returns daily at the same hour, p. 428.

R.

Rabies (Lat. *rabies*, rage or madness), canine madness, p. 421.

Racemose (Lat. *racemus*, a cluster of grapes), applied to a form of gland structure, p. 137.

Radius (Lat. *radius*, a ray or spoke of a wheel), applied to the outer bone of the forearm, p. 22.

Ranula (Lat. *ranula*, diminutive of *rana*, a frog), a cystic tumour of the mouth, p. 150.

Rectum (Lat. *rectus*, straight), the straight part (the end) of the bowel, p. 130.

Rete mucosum (Lat. *rete*, a net), applied to the deep layer of the scarf-skin, p. 307.

Rubefacient (Lat. *rubrum*, red, and *facio*, I make), applications which redden the skin, p. 914.

Rubella (diminutive of *rubeola*), p. 402.

Rubeola (Lat. *ruber*, red), measles, p. 400.

S.

Saccharoses (Lat. *saccharum*, sugar), the chemical term applied to a variety of sugars, p. 587.

Sacral, related to *os sacrum*, which see.

Saphenous (Gr. *saphēnēs*, manifest), applied to a superficial vein and nerve of the leg, p. 229.

Sarcinæ (Lat. *sarcina*, a pack or bundle), a genus of microscopic fungi, so called from its appearance, p. 162.

Sarcolemma (Gr. *sarx*, flesh, and *lemma*, a skin), the connective tissue sheath of muscular fibres, p. 68.

Sarcous (Gr. *sarx*, flesh), applied to certain elements of muscular fibres, p. 68.

Sartorius (Lat. *sartor*, a tailor), applied to a muscle, p. 74.

Scabies (Lat. *scabies*, a scab), the itch, p. 323.

Scaphoid (Gr. *skaphē*, a skiff or boat, and *eidos*, shape), a bone of the foot, p. 22.

Scapula (Gr. *skapanē*, a spade), the shoulder-blade, p. 21.

Schneiderian, applied to the lining membrane of the nostrils, so called from Schneider, who first described it, p. 338.

Sciatic (Gr. *ischion*, the hip), applied to nerves, vessels, &c., p. 99.

Sciatica, neuralgia in the district of the sciatic nerve, p. 128.

Scirrhus (Gr. *skirros*, a hard tumour), a form of cancer, p. 434.

Sclerosis (Gr. *sklēros*, hard), a state of hardening of connective tissue, p. 118.

Sclerostoma (Gr. *sklēros*, hard, and *stoma*, the mouth), applied to a genus of parasitic worms, p. 175.

Scolex (Gr. *skōlēx*, a worm), a stage in the development of tapeworm, p. 168.

Scorbutus, scurvy, p. 237.

Scultetus, a form of bandage, p. 959.

Sebaceous (Lat. *sebum*, suet), applied to glands secreting an oily substance, connected with hair-sacs, p. 308.

Seborrhœa (Lat. *sebum*, fat, and Gr. *reō*, I flow), excess of fatty secretion of the skin, p. 327.

Sedatives (Lat. *sedo*, I ease), applied to soothing remedies, p. 897.

Septicæmia (Gr. *sēptikos*, putrid, and *haima*, the blood), blood-poisoning, p. 236.

Sequestrum (Lat. *sequestro*, I sever), a portion of dead bone, p. 26.

Serratus (Lat. *serra*, a saw), applied to a muscle, p. 71.

Serum (Lat. *serum*, akin to Gr. *oros*, whey), the fluid of blood, less its fibrinous element, p. 216.

Sigmoid (Gr. *sigma*, a letter of the Greek alphabet, and *eidos*, likeness), applied to a bend of the large bowel, p. 130.

Sinus (Lat. *sinus*, a hollow), a channel leading from an abscess to the surface, p. 261.

Soleus (Lat. *solea*, a sandal), applied to a muscle of the calf of the leg, p. 74.

Soporific (Lat. *sopor*, sleep, and *facio*, I make), remedies which induce sleep, p. 904.

Sordes (Lat. *sordes*, filth), crusts which form on lips and teeth in persons in exhaustion from disease, p. 519.

Spermatozoa (Gr. *sperma*, seed, and *zōon*, an animal), the active constituents in the male element in conception, p. 484.

Sphenoid (Gr. *sphēn*, a wedge, and *eidos*, shape), a bone of the cranium, p. 19.

Sphincter (Gr. *sphingō*, I bind), applied to circular muscles which close outlets, p. 130.

Spica (Lat. *spica*, an ear of corn), a variety of bandage so called from a supposed resemblance to the rows of an ear of corn, p. 958.

Spina bifida (Lat. *spina*, the spine, and *bifida*, cleft), a malformation of the spine, p. 457.

Spirillum (Lat. diminutive of *spira*, a curl), a variety of micro-organisms, p. 388.

Spirometer (Lat. *spiro*, I breathe, and Gr. *metron*, a measure), an instrument for measuring quantity of air expelled from the chest, p. 256.

Splanchnic (Gr. *splanchna*, the bowel), applied to nerves, &c., p. 99.

Sporadic (Gr. *speirō*, to scatter), applied to infectious disease occurring in scattered cases, not as an epidemic, p. 4.

Squamous (Lat. *squama*, a scale), scaly, p. 16.

Staphyloma (Gr. *staphulē*, a bunch of grapes), a protrusion of the coats of the eyeball, p. 372.

Stasis (Gr. *staō*, I stop), a local stagnation of blood, p. 248.

Sternum, Lat. for breast-bone, p. 21.

Stertorous (Lat. *sterto*, I snore), having a snoring sound, p. 11.

Stethoscope (Gr. *stēthos*, the breast, and *skopeō*, I examine), the instrument used for listening to the sounds of the heart and breathing, p. 266.

Strabismus (Gr. *strabōs*, twisted), squint, p. 376.

Strobilus (Gr. *strobilos*, a pine cone), applied to the adult tapeworm, p. 168.

Strophulus (Gr. *strophos*, a twisting of the bowels, colic), an eruption on the skin of infants, referred to derangement of bowels, p. 319.

Struma, same as scrofula, p. 431.

Styptics (Gr. *stuphō*, I constringe), remedies applied externally to stop bleeding, p. 919.

Subacute (Lat. *sub*, under, and *acutus*, sharp), applied to disease not quite severe enough to be called acute, p. 4.

Sublingual (Lat. *sub*, under, and *lingua*, the tongue), applied to glands, vessels, &c., situated beneath the tongue, p. 137.

Submaxillary (Lat. *sub*, under, and *maxilla*, the jaw), applied to glands and other structures lying under cover of the jaw-bone, p. 137.

Sucroses, a chemical term for a variety of sugars, p. 587.

Sudamina (Lat. *sudor*, sweat), minute vesicles produced in the skin by excessive sweating, p. 328.

Sudorifics (Lat. *sudor*, sweat, and *facio*, I make), remedies which increase sweating, p. 887.

Sudoriparous (Lat. *sudor*, sweat, and *pario*, I produce), applied to sweat glands, p. 307.

Supination (Lat. *supino*, to bend back), the motion by which the palm of the hand is directed upwards, p. 22.

Suppository (Lat. *suppono*, I place below), a conical mass of material containing some drug to be pushed up into the bowel, p. 1051.

Suppuration (Lat. *suppuro*, to generate matter), the formation of matter, p. 248.

Suture (Lat. *suo*, to sew), the junction of bones of the skull, p. 20; thread, wire, &c., by which wounds are closed, p. 970.

Symblepharon (Gr. *sun*, together, and *blepharon*, the eyelid), a condition in which the eyelids have become united, p. 369.

Symphysis (Gr. *sun*, with, and *phuō*, I grow), applied to a junction of bone, p. 22.

Syncope (Gr. *sunkopē*, a faint), fainting, pp. 243, 991.

Synechia (Gr. *sunechō*, I hold together), a disease of the eye in which the iris adheres to the cornea (anterior), or to the capsule of the crystalline lens (posterior), p. 372.

Synovia (Gr. *sun*, with, and *ōon*, an egg), a fluid poured out in joints, closed sacs, to lubricate the joint, &c., p. 23.

Synovitis (*synovia* [which see], and terminal *itis*), an inflammation of joints, p. 32.

Systole (Gr. *sustellō*, I contract), the contraction of the heart, p. 224.

T.

Tabes mesenterica (Lat. *tabes*, a consumption, and *mesenterica*, connected with the bowel), consumption of the bowel, p. 165.

Tæniæ (Gr. *tainia*, a ribbon), tapeworm, p. 168.

Talipes (Lat. *talus*, an ankle, and *pes*, a foot), club-foot, p. 82.

Tapotement (French, a *tapping*), a term in use in massage, p. 772.

Tarsus (Gr. *tarsos*, any broad flat surface), the ankle, p. 23.

Tenesmus (Gr. *teinō*, I stretch), straining at stool, p. 186.

Therapeutics (Gr. *therapeuō*, I nurse or cure), the branch of medical science dealing with the action of remedies in disease, p. 810.

Thermometer (Gr. *thermē*, heat, and *metron*, measure), an instrument for determining degree of heat, p. 9.

Thorax (Gr. *thorax*, a breastplate), the chest, p. 20.

Thrombosis (Gr. *thrombos*, a clot), clotting of blood in vessels during life, p. 246.

Thrombus (Gr. *thrombos*, a clot), the clot formed in a vessel during life, p. 216.

Thymus (Gr. *thumos*, thyme), applied to the thymus gland (p. 205), because it was compared to the flower of the plant by Galen.

Thyroid (Gr. *thureos*, a shield, and *eidos*, likeness), applied to a gland in the neck, p. 250.

Tibia (Lat. *tibia*, a pipe or flute), the large bone of the fore-leg, p. 23.

Tonsillitis, inflammation of tonsils; quinsy, p. 155.

Tonsils (Lat. *tonsilla*), glandular structures in the mouth, p. 136.

Tormina (Lat., meaning griping), griping pains in the bowels, p. 186.

Torticollis (Lat. *tortum*, twisted, and *collum*, the neck), wry-neck, p. 77.

Tourniquet (French *tourner*, to turn), instruments applied for the arrest of bleeding, p. 980.

Toxicology (Gr. *toxikon*, poison, and *logos*, a discourse), the branch of medical science which treats of poisons and their antidotes, p. 1014.

Tracheotomy (Lat. *trachea*, the windpipe, and Gr. *temnō*, I cut), the operation for opening the windpipe, p. 262.

Trapezium and **Trapezoid** (Gr. *trapezion*, a small table), bones of the wrist, p. 22.

Trapezius, applied to a muscle, p. 71.

Traumatic (Gr. *trauma*, a wound), produced by injury, as a traumatic inflammation, p. 54.

Trematode (Gr. *trēma*, a hole, a pore), a group of internal parasites, p. 168.

Triceps (Lat. *tres*, three, and *caput*, a head), applied to a muscle of the arm, p. 72.

Trichina (Gr. *thrix*, a hair), a minute nematode worm, parasitic, p. 175.

Trichinosis, the disease due to trichina, p. 175.

Trichocephalus (Gr. *thrix*, hair, and *kephalē*, the head), a genus of worms, a species of which is found in the human intestine, p. 175.

Tricuspid (Lat. *tres*, three, and *cuspis*, a point), applied to certain teeth, p. 220.

Tripolar (Lat. *tres*, three, and *polus*, an axis), applied to nerve-cells with three processes, p. 85.

Trochanters (Gr. *trochanter*, from *trochos*, anything round), prominences of the hip-bone, p. 23.

Tubercle (Lat. *tuberculum*, a little swelling), applied to certain small nodules of cells produced by morbid action in organs, p. 945.

Tuberculosis, the disease due to tubercle, p. 165.

Tympanites (same deriv. as below), distension of belly with gas.

Tympanum (Lat., meaning a drum), the drum of the ear, p. 356.

Typhlitis (Gr. *tuphlon*, the blind end of the large bowel, and *itis*, signifying inflammation), inflammation of the blind end of the large bowel, p. 163.

U.

Ulna (Gr. *ōlenē*, the elbow), the inner bone of the fore-arm, p. 22.

Umbilicus (Lat.), the navel, p. 131.

Unciform (Lat. *uncus*, a hook, and *forma*, shape), a bone of the wrist, p. 22.

Unipolar (Lat. *unus*, one, and *polus*, an axis), applied to nerve-cells with one process, p. 85.

Uræmia (Gr. *ouron*, urine, and *haima*, blood), a state of blood-poisoning. It occurs in disease of the kidney from retention in the blood of substances which ought to be expelled in the urine, p. 293, 296.

Urethritis, inflammation of the urethra (from Gr. *ouron*, urine), p. 988.

Urticaria (Lat. *urtica*, a nettle), nettlerash, p. 314.

Uterine } (Lat. *uterus*, the womb), p. 479.
Uterus }

V.

Vaginitis, inflammation of the vaginal passage, p. 498.

Vagus (Lat., wandering), applied to a nerve from its wide distribution, p. 96.

Varicella (Lat., diminutive of *variola*, chicken-pox), p. 410.

Variola (Lat. *varius*, spotted), small-pox, p. 402.

Vascular (Lat. *vasculum*, a vessel), connected with or provided with vessels; applied to tissues containing blood-vessels, p. 835.

Vasomotor (Lat. *vasa*, vessels, and *motor*, a mover), applied to nerves controlling blood-vessels, p. 86, 233.

Venereal, applied to certain diseases connected with the sexual organs, p. 987.

Ventricles (Lat. *ventriculus*, diminutive of *venter*, the belly), a small cavity. V. of heart, p. 220, or brain, p. 91.

Vermicide (Lat. *vermis*, a worm, *cædo*, I kill), remedies which kill worms, p. 871.

Vermiform (Lat. *vermis*, a worm, and *forma*, shape), applied to a part of the large bowel, p. 130.

Vermifuge (Lat. *vermis*, a worm, and *fugo*, I drive out), remedies which expel worms, p. 871.

Vertebra (Lat. *vertebra*, a joint), applied to each of the bones forming the back-bone, p. 20.

Vertigo (Lat. *verto*, I turn), giddiness, p. 113.

Vesicant (Lat. *vesica*, a blister). Remedies which blister, p. 914.

Vibrio (Lat. *vibrio*, I shake), a variety of bacteria, p. 388.

Vomer (Lat. *vomer*, a ploughshare), the bone dividing the nasal cavity into two, p. 19.

Vulvitis, inflammation of the vulva, p. 498.

Z.

Zygoma (Gr. *zygon*, a yoke), a process of cheekbone connecting it with the temple, p. 19.

Zymosis (Gr. *zymē*, ferment), an infectious disease, p. 4.

Zymotic, of the nature of zymosis, p. 4.

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THE HUMAN BODY.

DISSECTION OF THE ABDOMEN AND ITS CONTENTS.

1 represents the skin of the abdomen before dissection.

2 shows the muscles of the abdominal wall when the skin and underlying fat have been dissected off.

3 The stomach. 4 The liver. 5 The curve of the first part of the small intestine—duodenum.

6, 7, 8 are on different parts of the pancreas.

9 is on the spleen.

10 is surrounded by coils of the small intestine.

11A, 11B, 11C the ascending, transverse, and descending parts of the large bowel.

11D is on the termination of the large bowel, the rectum.

12 is placed on the upper part of the bladder.

13 is on the left and 14 on the right kidney, and 15 on the ureters leading from them to the bladder.

16 is on the ascending vena cava, 17 on the descending aorta.

This plate shows that when the front wall of the abdomen has been removed the main portion of the cavity is seen to be occupied by the coils of the small intestine, the large intestine lying somewhat behind and passing up on the right side to the lower border of the liver, then bending to pass across to the left side, there again bending to pass downward towards the left groin, where it performs an S-like turn upon itself, and then continues straight to its outlet. The plate shows the liver on the upper right side of the cavity, and the greater curvature of the stomach on the upper left side, the spleen lying close to the left border of the stomach.

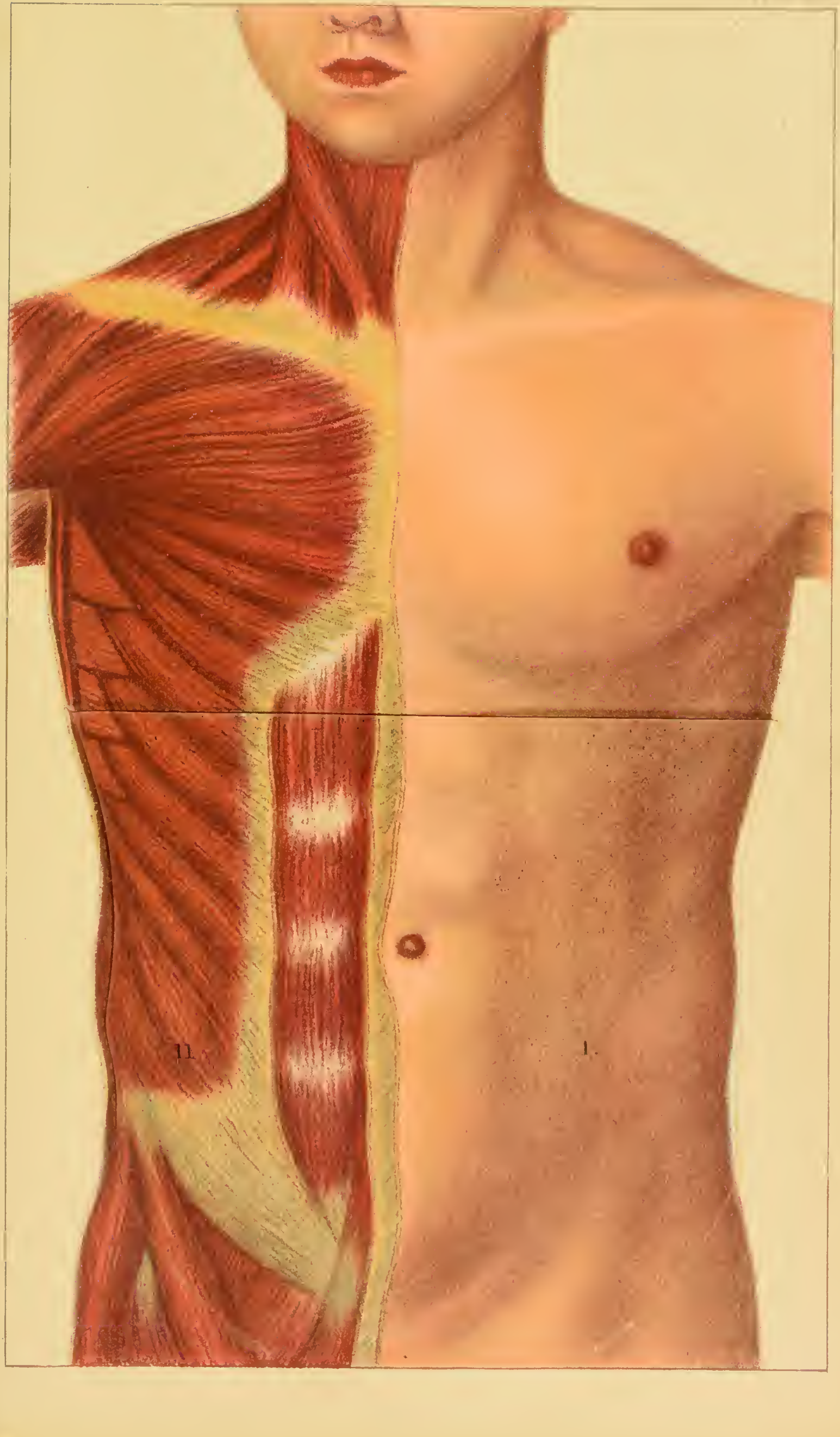
If the lower edge of the liver and stomach be slightly turned up, the commencement of the small intestine is seen sweeping in a curve from the narrow end of the stomach, and in the bend thus formed lies the large end of the pancreas, which, when the stomach is distended, lies behind that organ.

If the intestines be removed the kidneys are seen to lie close to the back wall of the cavity, and the ducts (ureters) leading from them to the bladder are shown. The bladder is represented distended, so that it peeps up above the level of the front part of the haunch bone.

For full information regarding the Digestive System, see page 129.

THE HUMAN BODY.

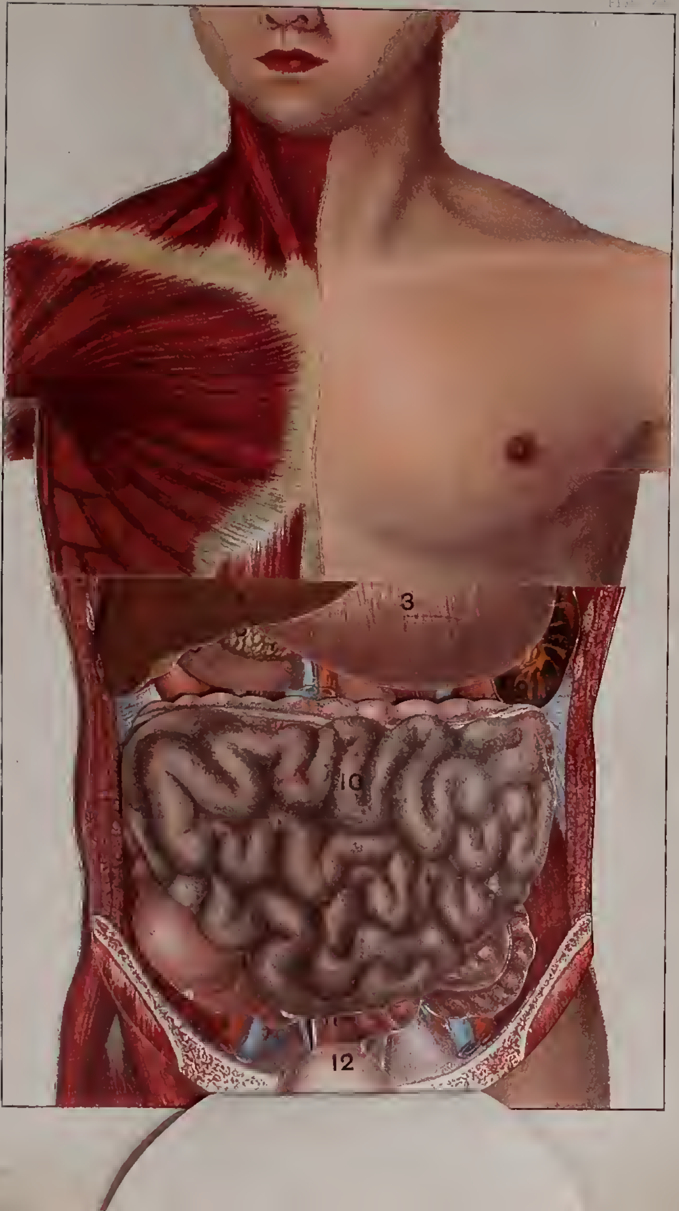
DISSECTION OF THE ABDOMEN AND ITS CONTENTS



THE HUMAN BODY.

DISSECTION OF THE ABDOMEN AND ITS CONTENTS.

Fig. [illegible]



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